TRANSLATION

I, Yuko Mitsui, residing at 4-6-10, Higashikoigakubo, Kokubunji-shi, Tokyo, Japan, state:

that I know well both the Japanese and English languages,

that I translated, from Japanese into English, Japanese Patent Application No. 2003-092072, filed on March 28, 2003, and

that the attached English translation is a true and accurate translation to the best of my knowledge and belief.

Dated: May 24, 2005

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PATENT OFFICE
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This is to certify that the annexed is a true copy of the following application as filed with this Office.

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Applicant(s): OLYMPUS OPTICAL CO., LTD.

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[Title of the Invention] REFLECTION SCREEN APPARATUS AND PROJECTION SYSTEM

[What is claimed is:]

[Claim 1] A reflection screen apparatus characterized in that a projection apparatus projects an image based on received image data and an observer observes the image, characterized by comprising:

a screen reflection surface which visibly diffuses and reflects the image projected by the projection apparatus to the observer; and

light distribution correction means for changing a state of a distribution direction of a light reflected on the screen reflection surface so as to more reflect a diffused light reflected on the screen reflection surface to the observer.

[Claim 2] The reflection screen apparatus according to claim 1, characterized by further comprising:

projected luminous flux incident angle detection means for detecting an angle of the projected light of the projection apparatus made incident on the screen reflection surface, characterized in that

the light distribution correction means changes the state of the distribution direction of the light reflected on the screen reflection surface based on the angle detected by the projected luminous flux incident angle detection means.

[Claim 3] The reflection screen apparatus according to claim 2, characterized by further comprising screen light distribution angle storage means for storing the light distribution angle of the light reflected on the screen

reflection surface, characterized in that

the light distribution correction means changes the state of the distribution direction of the light reflected on the screen reflection surface based on the angle detected by the projected luminous flux incident angle detection means and the light distribution angle stored by the screen light distribution angle storage means.

[Claim 4] The reflection screen apparatus according to claim 2, characterized in that

the projected luminous flux incident angle detection means includes:

a condenser lens arranged on a front side of the screen reflection surface; and

photodetection means for detecting a light condensed by the condenser lens, and

the projected luminous flux incident angle detection means detects the angle of the light made incident on the screen reflection surface based on a light spot position or an amount of a light detected by the photodetection means.

[Claim 5] The reflection screen apparatus according to claim 1, characterized in that

the screen reflection surface has a preset reflected light distribution angle, and

the light distribution correction means changes the state of the distribution direction of the light reflected on the screen reflection surface by deforming the screen reflection surface to be a concave surface shape seen from the observer.

[Claim 6] The reflection screen apparatus according to

claim 5, characterized in that the light distribution correction means deforms the screen reflection surface to be the concave surface shape along deformation wires arranged on both ends of the screen reflection surface.

[Claim 7] The reflection screen apparatus according to claim 1, characterized in that the light distribution correction means comprises:

deformation pattern storage means for storing a plurality kinds of deformation shape patterns of the screen reflection surface; and

deformation pattern selection means for causing the observer to select one of the deformation shape patterns stored by the deformation pattern storage means, and

the light distribution correction means deforms a shape of the screen reflection surface based on the deformation shape pattern selected by the deformation pattern selection means.

[Claim 8] The reflection screen apparatus according to claim 1, characterized by further comprising:

observer covering area setting means for setting an observer covering area that is information on a position in which the observer is present, and

screen light distribution angle storage means for storing the light distribution angle of the light reflected on the screen reflection surface, and in that

the light distribution correction means includes

deformation amount display means for calculating an optimal deformation amount of the screen reflection surface based on the incident angle of the light on the screen

reflection surface detected by the projected luminous flux incident angle detection means, the observer covering area set by the observer covering area setting means, and the light distribution angle stored by the screen light distribution angle storage means, and displaying the obtained optical deformation amount;

deformation pattern storage means for storing the deformation shape patterns of the screen reflection surface; and

deformation pattern selection means for causing the observer to select one of the deformation shape patterns stored by the deformation pattern storage means based on the optimal deformation amount displayed by the deformation amount display means, and

the light distribution correction means deforms the shape of the screen reflection surface based on the deformation shape pattern selected by the deformation pattern selection means.

[Claim 9] The reflection screen apparatus according to claim 1, characterized by further comprising photoelectric conversion means for converting a light projected on the screen reflection surface into power, and supplying the power to the light distribution correction means, characterized in that

the light distribution correction means changes the state of the light distribution direction on the screen reflection surface by using the power supplied from the photoelectric conversion means.

[Claim 10] The reflection screen apparatus according to claim 1, characterized by further comprising observer covering

area setting means for setting an observer covering area that is information on a position in which the observer is present, characterized in that

the light distribution correction means changes the state of the light distribution direction on the screen reflection surface based on the observer covering area set by the observer covering area setting means.

[Claim 11] The reflection screen apparatus according to claim 10, characterized in that

the observer covering area setting means has:

at least one marker means for emitting light to at least the screen reflection surface; and

marker position detection means for receiving the light emitted from the marker means to obtain a coordinate position of the marker means relative to the screen reflection surface, and

the observer covering area setting means sets the observer covering area based on the coordinate position obtained by the marker position detection means.

[Claim 12] The reflection screen apparatus according to claim 11, characterized in that the observer covering area setting means sets a space surrounded with a plurality of marker coordinates obtained by the marker position detection means as the observer covering area.

[Claim 13] The reflection screen apparatus according to claim 11, characterized in that the observer covering area setting means sets a space that has a predetermined spatial spread including the marker coordinate obtained by the

marker position detection means as the observer covering area.

[Claim 14] The reflection screen apparatus according to claim 1, characterized in that the light distribution correction means has at least one photodetection sensor means for receiving the light reflected on the screen reflection surface to detect an amount thereof, and changes the state of the light distribution direction on the screen reflection surface in such a way that a total amount of the light detected by the photodetection sensor means becomes maximum.

[Claim 15] The reflection screen apparatus according to claim 1, characterized in that the light distribution correction means

has a plurality of photodetection sensor means for receiving the light reflected on the screen reflection surface to detects an amount thereof, and

changes the state of the light distribution direction on the screen reflection surface in such a way that a difference in amounts of lights detected by the plurality of photodetection sensor means becomes minimum.

[Claim 16] The reflection screen apparatus according to claim 1, characterized in that the screen reflection surface comprises:

a plurality of movable micro-diffusion and reflection surfaces are disposed on the screen reflection surfaces, and

the light distribution correction means changes the state of the direction of the light reflected on the screen reflection surface by moving the micro-diffusion and reflection surfaces.

[Claim 17] The reflection screen apparatus according to claim 16, characterized in that the micro-diffusion and reflection surfaces hold deformation by electrostatic forces.

[Claim 18] A projection system using a reflection screen apparatus according to claim 1, characterized by comprising:

screen deformation amount detecting means for detecting the deformation amount of the screen reflection surface deformed by the light distribution correction means; and

image correction means for executing image correction for the image data sent to the projection apparatus based on the deformation amount detected by the screen deformation amount detecting means.

[Claim 19] The projection system according to claim 18, characterized in that the image correction executed by the image correction means is a distortion correction of an image.

[Claim 20] The projection system according to claim 18, characterized in that the image correction executed by the image correction means is a non-uniform luminance correction of an image.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a reflection screen apparatus which reflects an image projected by a projection apparatus based on optimal light distribution, and to a projection system using the same.

[0002]

[Prior Art]

In a projector of a so-called front projection type, various ideas have been tried so that a brighter light can be obtained for an observer by converging luminous flux reflected by the screen to the observer and reducing useless light reflected to the outside of the observer's visual field as much as possible.

[0003]

Accordingly, many inventions or commercial products have been presented regarding a reflection screen of high directivity in which the reflected light distribution angle of a screen reflection surface is narrowed. As opposed to a conventional white matte screen of a wide light distribution angle, a silver screen, a pearl screen, a bead screen, a hologram screen, etc., can be cited as representative screens that have been in practical use. Moreover, various ideas have been presented to increase directivity by a structure such as a shape of a screen reflection surface (For example, refer to Pat. Document 1 to Pat. Document 4). Thus, since the amount of a light can be increased for the observer in a condensed manner by the screen of a small light distribution angle, a demand therefore tends to increase more and more.

[0004]

Recently, however, widespread use of projectors has increased the need for projection on a large screen even at a place of limited space, consequently increasing short-focus projectors. Thus, an incident angle of a projected luminous

flux made incident on a screen end surface inevitably becomes steep on a general plane screen, creating a situation in which a direction itself of the reflected light distribution thereof is shifted more to an area outside the observer. A problem of the impossibility of achieving an original object occurs even on the screen reflection surface of a small light distribution angle.

[0005]

On the other hand, disclosed is a screen apparatus that has, a means for deforming the entire screen reflection surface to a predetermined curved surface shape, and changes light distribution angle characteristics by setting a plane state when observation is carried out at a wide light distribution angle by many people, and setting a curved surface shape when observation is carried out at a narrow light distribution angle by a small number of people (For example, refer to Pat. Document 5). Additionally, a surface inspection apparatus or the like based on an image obtained by simply making variable a curvature of a curved surface shape of a screen reflection surface and concentrating a reflected light on a predetermined object is presented (for example, refer to Pat. Document 6). According to this method, it is possible to effectively provide bright images to an observer by making effective use of screen reflection characteristics of a small light distribution angle.

[0006]

[Pat. Document 1]

Jpn. Pat. Appln. KOKAI Publication No. 6-242511

[0007]

[Pat. Document 2]

Jpn. Pat. Appln. KOKAI Publication No. 5-45733

[0008]

[Pat. Document 3]

Jpn. Pat. Appln. KOKAI Publication No. 2000-275755

[0009]

[Pat. Document 4]

Jpn. Pat. Appln. KOKAI Publication No. 10-26802

[0010]

[Pat. Document 5]

Jpn. Pat. Appln. KOKAI Publication No. 5-297466

[0011]

[Pat. Document 6]

Jpn. Pat. Appln. KOKAI Publication No. 8-114430

[0012]

[Objects of the Invention]

The aforementioned conventional screens are all based on the assumption of deformation to predetermined curved surface shapes. Consequently, there is no concept of correction in adaptation to a state of a projected luminous flux changed depending on an installation position of a projector or an area that covers an observer for whom the luminous flux is originally reflected in a corresponding manner. Thus, a problem of the impossibility of flexibly dealing with the installed state of the projector remains to be solved.

[0013]

The present invention has been made with the foregoing

problems in mind, and objects of the invention are to provide a reflection screen apparatus that can adaptively correct a light distribution on a screen reflection surface in accordance with an angle of a projected luminous flux made incident on the screen reflection surface, reflected light distribution characteristics thereof, and a set state of an area which covers an observer for whom reflected light is condensed, and effectively condense the reflected luminous flux of the screen reflection surface for the observer, and a projection system using the same.

[0014]

[Means for Achieving the Object]

In order to achieve the above mentioned object, the reflection screen apparatus according to the invention described in claim 1 is a screen in which a projection apparatus projects an image based on received image data and an observer observes the image, characterized by comprising a screen reflection surface which visibly diffuses and reflects the image projected by the projection apparatus to the observer; and light distribution correction means for changing a state of a distribution direction of a light reflected on the screen reflection surface so as to more reflect a diffused light reflected on the screen reflection surface to the observer.

[0015]

This composition corresponds to FIG. 1 to FIG. 20.

More specifically, according to a reflection screen apparatus of the invention described in claim 1, the screen

reflection surface can be properly deformed to match the light distribution range of the reflected luminous flux on the screen reflection surface with the area that covers the observers. Therefore, it is possible to effectively condense the reflected luminous flux of the screen reflection surface on the observers.

[0016]

Further, the reflection screen apparatus described in claim 2, according to the reflection screen apparatus of the invention described in claim 1, characterized by further comprising a projected luminous flux incident angle detection means for detecting an angle of the projected light of the projection apparatus made incident on the screen reflection surface, characterized in that the light distribution correction means changes the state of the distribution direction of the light reflected on the screen reflection surface based on the angle detected by the projected luminous flux incident angle detection means.

[0017]

This composition corresponds to FIG. 2 to FIG. 4. Namely, according to a reflection screen apparatus of the invention described in claim 2, a light distribution range of the reflected luminous flux on the screen reflection surface is obtained based on the incident angle of the projected luminous flux thereon, and the screen reflection surface can be properly deformed to match the range with the area that covers the observers. Therefore, it is possible to effectively condense the reflected luminous flux of the screen reflection surface on the observers.

[0018]

Further, the reflection screen apparatus described in claim 3, according to the reflection screen apparatus of the invention described in claim 2, characterized by further comprising a screen light distribution angle storage means for storing the light distribution angle of the light reflected on the screen reflection surface, characterized in that the light distribution correction means changes the state of the distribution direction of the light reflected on the screen reflection surface based on the angle detected by the projected luminous flux incident angle detection means and the light distribution angle stored by the screen light distribution angle storage means.

[0019]

This composition corresponds to the projected luminous flux incident angle detection means shown in FIG. 2 to FIG. 4.

Incidentally, in the specification, "light distribution angle" means a diffusing and spreading angle thereof when light rays made incident on the screen are reflected from the same spot of the screen reflection surface.

Namely, according to the reflection screen apparatus of the invention described in claim 3, change state of the distribution direction of the light reflected on the screen reflection surface in accordance with the angle detected by the projected luminous flux incident angle detection means can easily be obtained from the light distribution angle stored by the screen light distribution angle storage means.

[0020]

Further, the reflection screen apparatus of the invention described in claim 4, according to the reflection screen apparatus of the invention described in claim 2, characterized in that the projected luminous flux incident angle detection means comprises: a condenser lens arranged on a front side of the screen reflection surface; and a photodetection means for detecting a light condensed by the condenser lens, and the projected luminous flux incident angle detection means detects the angle of the light made incident on the screen reflection surface based on a light spot position or an amount of a light detected by the photodetection means.

[0021]

This composition corresponds to the projected luminous flux incident angle detection means shown in FIG. 2, FIG. 4, and FIG. 11.

[0022]

According to the reflection screen apparatus of the invention described in claim 4, it is possible to easily detect the angle of the luminous flux made incident on the screen reflection surface by detecting the light spot position or the amount of the light thereon.

[0023]

Furthermore, the reflection screen apparatus of the invention described in claim 5, according to the reflection screen apparatus of the invention described in claim 1, characterized in that the screen reflection surface comprises a preset reflected light distribution angle, and the light

distribution correction means changes the state of the distribution direction of the light reflected on the screen reflection surface by deforming the screen reflection surface to be a concave surface shape seen from the observer.

[0024]

This composition corresponds to a state in which the light distribution is controlled by bending the screen reflection surface shown in FIG. 15.

[0025]

According to the reflection screen apparatus of the invention described in claim 5, the light distribution control with the two-dimensional deformation that bends the screen reflection surface enables more effective condensation of the reflected luminous flux thereof on the observer.

[0026]

Further, the reflection screen apparatus of the invention described in claim 6, according to the reflection screen apparatus of the invention described in claim 5, characterized in that the light distribution correction means deforms the screen reflection surface to be the concave surface shape along deformation wires arranged on both ends of the screen reflection surface.

[0027]

This composition corresponds to the deformation mechanism of the screen reflection surface shown in FIG. 6.

[0028]

According to the reflection screen apparatus of the invention described in claim 6, a bend of the screen reflection

surface can be realized by a simple deformation mechanism which deforms the screen reflection surface to be the concave surface shape along the deformation wires arranged on both ends of the screen reflection surface.

[0029]

Furthermore, the reflection screen apparatus described in claim 7, according to the reflection screen apparatus of the invention described in claim 1, characterized in that the light distribution correction means has: a deformation pattern storage means for storing a plurality kinds of deformation shape patterns of the screen reflection surface; and a deformation pattern selection means for causing the observer to select one of the deformation shape patterns stored by the deformation pattern storage means, and the light distribution correction means deforms a shape of the screen reflection surface based on the deformation shape pattern selected by the deformation pattern selection means.

[0030]

This composition corresponds to the deformation pattern storage section, and deformation pattern selection section, shown in FIG. 3.

[0031]

According to the reflection screen apparatus of the invention described in claim 7, a shape of the screen reflection surface is deformed based on a single selection from a plurality of deformation shape patterns stored by the observer in advance, therefore, the screen reflection surface can be deformed in a suitable shape with respect to the

position of the observer, enabling more effective condensation of the reflected luminous flux of the screen reflection surface on the observer.

[0032]

Further, the reflection screen apparatus described in claim 8, according to the reflection screen apparatus of the invention described in claim 1, further comprises an observer covering area setting means for setting an observer covering area that is information on a position in which the observer is present, and a screen light distribution angle storage means for storing the light distribution angle of the light reflected on the screen reflection surface, and in that the light distribution correction means includes a deformation amount display means for calculating an optimal deformation amount of the screen reflection surface based on the incident angle of the light on the screen reflection surface detected by the projected luminous flux incident angle detection means, the observer covering area set by the observer covering area setting means, and the light distribution angle stored by the screen light distribution angle storage means, and displaying the obtained optical deformation amount; deformation pattern storage means for storing the deformation shape patterns of the screen reflection surface; and deformation pattern selection means for causing the observer to select one of the deformation shape patterns stored by the deformation pattern storage means based on the optimal deformation amount displayed by the deformation amount display means, and the light distribution correction means deforms the shape of the

screen reflection surface based on the deformation shape pattern selected by the deformation pattern selection means.

[0033]

This composition corresponds to the deformation amount display section, deformation pattern storage section, and deformation pattern selection section, shown in FIG. 3.

[0034]

According to the reflection screen apparatus of the invention described in claim 8, an optimal deforming amount of the screen reflection surface obtained in accordance with the setting of the observer covering area is displayed, and the observer selects one of the deformation shape patterns based on the displayed optimal deformation amount to thereby deform the shape of the screen reflection surface. Therefore, the screen reflection surface can be optimally deformed in a shape requested by the observer, enabling more effective condensation of the reflected luminous flux of the screen reflection surface on the observer.

[0035]

Furthermore, the reflection screen apparatus described in claim 9, according to the reflection screen apparatus of the invention described in claim 1, further comprises

a photoelectric conversion means for converting a light projected on the screen reflection surface into power, and supplying the power to the light distribution correction means, characterized in that the light distribution correction means changes the state of the light distribution direction on the screen reflection surface by using the power supplied from the

photoelectric conversion means.

[0036]

This composition corresponds to the photoelectric conversion, shown in FIG. 6.

[0037]

According to the reflection screen apparatus of the invention described in claim 9, the light projected on the screen reflection surface is converted into power by the photoelectric conversion means, and the power is used as a driving power supply for the mechanism of changing the state of the light distribution direction on the screen reflection surface. Therefore, there is no need to prepare another power supply for the mechanism of changing the light distribution direction state of the screen reflection surface, which contributes to energy saving.

[0038]

Further, the reflection screen apparatus of the invention described in claim 10, according to the reflection screen apparatus of the invention described in claim 1, further comprises an observer covering area setting means for setting an observer covering area that is information on a position in which the observer is present, characterized in that the light distribution correction means changes the state of the light distribution direction on the screen reflection surface based on the observer covering area set by the observer covering area setting means.

[0039]

This composition corresponds to FIG. 1, FIG. 3, FIG. 9 and

FIG. 10.

[0040]

Namely, according to the reflection screen apparatus of the invention described in claim 10, the state of the light distribution direction on the screen reflection surface can be changed based on the setting of the observer covering area, that is the information on the position in which the observer is present, enabling reliable condensation of the reflected luminous flux of the reflection screen surface on the observer.

[0041]

Furthermore, the reflection screen apparatus described in claim 11, according to the reflection screen apparatus of the invention described in claim 10, characterized in that the observer covering area setting means has: at least one marker means for emitting light to at least the screen reflection surface; and a marker position detection means for receiving the light emitted from the marker means to obtain a coordinate position of the marker relative to the screen reflection surface, and the observer covering area setting means sets the observer covering area based on the coordinate position obtained by the marker position detection means.

[0042]

This composition corresponds to FIG. 9.

[0043]

According to the reflection screen apparatus of the invention described in claim 11, the light emitted from the marker means is received to obtain a coordinate position of the marker means relative to the screen reflection surface, and the

observer covering area is set based on the obtained coordinate position, enabling to set accurately the observer covering area where the observer exists.

[0044]

Further, the reflection screen apparatus described in claim 12, according to the reflection screen apparatus of the invention described in claim 11, characterized in that the observer covering area setting means sets a space surrounded with a plurality of marker coordinates obtained by the marker position detection means as the observer covering area.

[0045]

This composition corresponds to FIG. 10.

[0046]

According to the reflection screen apparatus of the invention described in claim 12, it is possible to set the observer covering area more accurately by setting the space surrounded with a plurality of marker coordinates as the observer covering area.

[0047]

Furthermore, the reflection screen apparatus described in claim 13, according to the reflection screen apparatus of the invention described in claim 11, characterized in that the observer covering area setting means sets a space that has a predetermined spatial spread including the marker coordinate obtained by the marker position detection means as the observer covering area.

[0048]

This composition corresponds to FIG. 10.

[0049]

According to the reflection screen apparatus of the invention described in claim 13, since a space that has a predetermined spatial spread including the detected marker coordinate is set as an observer covering area, even if there are a plurality of observers around the marker position, the space that includes the plurality of observers can be set as an observer covering area. As a result, it is possible to surely condense the reflected luminous flux of the screen reflection surface on the plurality of observers.

[0050]

Further, the reflection screen apparatus described in claim 14, according to the reflection screen apparatus of the invention described in claim 1, characterized in that the light distribution correction means has at least one photodetection sensor means for receiving the light reflected on the screen reflection surface to detect an amount thereof, and changes the state of the light distribution direction on the screen reflection surface in such a way that a total amount of the light detected by the photodetection sensor means becomes maximum.

[0051]

This composition corresponds to the remote controller with a built-in photodetection secsor, shown in FIG. 7 and FIG. 8.

[0052]

According to the reflection screen apparatus of the invention described in claim 14, at least one photodetection sensor means receives the light reflected on the screen

reflection surface, and changes the state of the light distribution direction on the screen reflection surface in order to maximize the total amount of received light. Therefore, it is possible to surely condense the reflected luminous flux of the screen reflection surface on the observers by holding the photodetection sensor means at the observer or the like to set the position of the photodetection sensor means substantially identical to that of the observer.

[0053]

Furthermore, the reflection screen apparatus described in claim 15, according to the reflection screen apparatus of the invention described in claim 1, characterized in that the light distribution correction means comprises a plurality of photodetection sensor means for receiving the light reflected on the screen reflection surface to detect an amount thereof, and changes the state of the light distribution direction on the screen reflection surface in such a way that a difference in amounts of lights detected by the plurality of photodetection sensor means becomes minimum.

[0054]

This composition corresponds to the remote controller with a built-in photodetection sensor, shown in FIG. 7 and FIG. 8.

[0055]

According to the reflection screen apparatus of the invention described in claim 15, the light reflected on the screen reflection surface is received with the plurality of photodetection sensor means and the state of the light distribution direction on the screen reflection surface is

changed in such a way that a difference in amounts of lights received. Therefore, it is possible to surely condense the reflected luminous flux of the screen reflection surface in the area that includes the observers by holding the photodetection sensor means at the observer or the like to set the position of the photodetection sensor means substantially identical to that of the observer.

[0056]

Still further, the reflection screen apparatus described in claim 16, according to the reflection screen apparatus of the invention described in claim 1, characterized in that the screen reflection surface has a plurality of movable micro-diffusion and reflection surfaces are disposed on the screen reflection surface, and the light distribution correction means changes the state of the direction of the light reflected on the screen reflection surface by moving the micro-diffusion and reflection surfaces.

[0057]

This composition corresponds to FIG. 16.

[0058]

According to the reflection screen apparatus of the invention described in claim 16, when the state of the direction of light reflected on the screen reflection surface is changed, the reflection surface disposed on the screen reflection surface moves each of the plurality of movable micro-diffusion and reflection surfaces. Therefore, finer control can be carried out by the micro-diffusion and reflection surface units.

[0059]

Furthermore, the reflection screen apparatus described in claim 17, according to the reflection screen apparatus of the invention described in claim 16, characterized in that the micro-diffusion and reflection surfaces holds deformation by electrostatic forces.

[0060]

This composition corresponds to the charged film/thin plate system in FIG. 17, and charged rotary plate system in FIG. 18.

[0061]

According to the reflection screen apparatus of the invention described in claim 17, the deformation of the micro-diffusion and reflection surfaces is held by electrostatic forces, which enables saving of energy.

[0062]

Still further, the projection system described in claim 18 is a projection system using the reflection screen apparatus described in claim 1, characterized by comprising a screen deformation amount detecting means for detecting the deformation amount of the screen reflection surface deformed by the light distribution correction means, and an image correction means for executing image correction for the image data sent to the projection apparatus based on the deformation amount detected by the screen deformation amount detection means.

[0063]

This composition corresponds to FIG. 1 and FIG. 8.

[0064]

According to the projection system of the invention described in claim 18, the image correction is conducted for the image data sent to the projection apparatus based on the deformation amount of the screen reflection surface. Therefore, even the screen reflection surface is deformed, the image observed by the observer can be prevented from generating any deformation.

[0065]

Moreover, the projection system described in claim 19, according to the projection system of the present invention described in claim 18, characterized in that the image correction executed by the image correction means is a distortion correction of an image.

[0066]

This composition corresponds to FIG. 1 and FIG. 8.

[0067]

According to the projection system of the invention described in claim 19, since the distortion correction of the image is executed as the image correction, the observer can observe the image with no distortion.

[0068]

Further, the projection system of the invention described in claim 20, according to the projection system of the invention described in claim 18, characterized in that the image correction executed by the image correction means is a non-uniform luminance correction of an image.

[0069]

This composition corresponds to FIG. 1 and FIG. 8.

[0070]

According to the projection system of the invention described in claim 20, since the non-uniform luminance correction of the image is executed as the image correction, the observer can observe the image with no non-uniform luminance.

[0071]

[Embodiments of the Invention]

Hereinafter, embodiments of the present invention will be explained with reference to the figures.

[0072]

[First Embodiment]

FIG. 1(A) is a view showing a state of using a reflection screen apparatus according to a first embodiment of the present invention, and a projection system that uses the same.

[0073]

As shown in the left side of the figure, when an image is projected onto a planar screen 101 by a projection apparatus 2, a projected luminous flux is made incident on a planar screen reflection surface of the screen 101, and reflected as a reflected luminous flux in accordance with a reflected light distribution angle that the screen reflection surface has. This reflected luminous flux only needs to enter eyes of observers 3. Namely, it only needs to enter the observation area 4, which surrounds the observers 3, and reflected luminous fluxes on other areas, e.g., a ceiling, a desk, etc., are

wasted. Thus, as shown in the right side of the figure, the screen reflection surface is deformed to condense the reflected luminous flux in the observation area 4, whereby bright images can be effectively provided to the observers 3. As for the deformation, according to the embodiment, the observation area 4 is detected or set to adaptively deform the screen reflection surface, and luminous fluxes reflected on the screen reflection surface are efficiently condensed on the observers 3.

[0074]

FIG. 1(B) is a functional block diagram showing a basic configuration of the projection system according to the first embodiment.

[0075]

The projection system according to the embodiment comprises a reflection screen apparatus 100 of the embodiment, the projection apparatus 2, and an image correction means 5. The reflection screen apparatus 100 comprises a light distribution correction command section 102, a projected luminous flux incident angle detection section 103, an observer covering area setting section 104, a screen light distribution angle storage section 105, a screen reflection surface deformation control section 106 functioning as a light distribution correction means, and a screen reflection surface deformation driving section 107.

[0076]

Here, the light distribution correction command section 102 of the reflection screen apparatus 100 instructs projection onto the projection apparatus 2 according to an operation of

the operation button (not shown in the figure) by the observer 3, and outputs the light distribution correction command to the projected luminous flux incident angle detection section 103 and the screen reflection surface deformation control section 106.

[0077]

The above projected luminous flux incident angle detection section 103 detects an angle of a luminous flux made incident on the screen reflection surface 108 from the projection apparatus 2 according to the light distribution correction commend noted above.

[0078]

By the operation of the observer 3 of the operation button (not shown), the observer covering area setting section 104 sets an observer covering area that is information about a position in which the observer 3 exists.

[0079]

The screen light distribution angle storage section 105 stores data of a light distribution angle that the screen reflection surface 108 has as reflection characteristics.

[0080]

The screen reflection surface deformation control section 106 controls deformation of the screen reflection surface 108 in accordance with the light distribution correction command.

[0081]

The screen reflection surface deformation driving section 107 drives deformation of the screen reflection surface 108 based on the control of the screen reflection surface

deformation control section 106.

[0082]

Incidentally, in the above constitution, not all of the projected luminous flux incident angle detection section 103, the observer covering area setting section 104, and the screen light distribution angle storage section 105 are necessary. As in the case of each embodiment described below, these sections may be used as occasion demands.

[0083]

According to the reflection screen apparatus 100 of the foregoing constitution, the screen reflection surface deformation control section 106 calculates an amount of deformation to provide an optimal light distribution to the observer covering area based on at least one of the incident angle of the luminous flux on the screen reflection surface 108 which has been detected by the projected luminous flux incident angle detection section 103, the data of the light distribution angle which the screen reflection surface 108 has as the reflection characteristics and which has been stored by the screen light distribution angle storage section 105, and the setting of the observer covering area by the observer covering area setting section 104. Then, a control amount thereof is provided to the screen reflection surface deformation driving section 107. The screen reflection surface deformation driving section 107 deforms the screen reflection surface 108 based on the control amount. Accordingly, the reflected light is effectively supplied from the screen reflection surface 108 to the observer 3.

[0084]

Furthermore, according to the projection system of the present invention, the screen reflection surface, deformation control section 106 obtains data to correct distortion or non-uniform luminance of the projected image which occurs in accordance with the deformation amount of the screen reflection surface 108, and supplies the information to the image correction means 5. At the same time, the image correction means 5 executes correction to improve the projected image based on image data input for projection to be input. Then, the corrected image data is input to the projection apparatus 2 to be projected to the deformed screen reflection surface 108. Thus, even if the screen reflection surface 108 is deformed, the observer 3 can observe an image substantially similar to that in the case of no deformation.

[0085]

Incidentally, the above-mentioned amount of correction executed in accordance with the deformation amount of the screen reflection surface 108 is obtained beforehand to be represented in a function or a table. Further, the deformation of the screen reflection surface 108 may be accompanied by a necessity of defocusing correction in addition to the correction of the distortion or the nonuniform luminance. Thus, as a function of the image correction means 5, for example, an automatic lens replacement function or the like may be constituted to execute not only image data correction but also optical defocusing correction.

[0086]

Therefore, the deformation of the screen reflection surface 108 enables the observer 3 to observe an image substantially similar to that in the case of no deformation but increased in amount.

[0087]

Needless to say, the image correction means 5 may be incorporated in one of the reflection screen apparatus 100 and the projection apparatus 2.

[0088]

[Second Embodiment]

Next, as a second embodiment of the present invention, description will be made of deformation executed in accordance with incident angle detection of a luminous flux by the projected luminous flux incident angle detection section 103.

[0089]

FIG. 2 shows a constitution of a screen 101 according to the second embodiment, and FIG. 3 is a functional block diagram showing a constitution for detecting a projected luminous flux incident angle.

[0090]

That is, as shown in FIG. 2, a plurality of pieces (N pieces) of micro-convex lenses 103A for light condensation and corresponding light spot position detection sensors 103B are attached to predetermined positions, e.g., inconspicuous positions near an upper end and a lower end, of the screen 101. According to this constitution, a condensing position y of a projected light of the projection apparatus 2 on the light

spot position detection sensor 103B by the micro-convex lens 103A for light condensation is changed in accordance with the angle of the projected light made incident from the projection apparatus 2 on the screen reflection surface 108. Thus, it is possible to find out the incident angle of the projected light with respect to the position of the screen reflection surface 108 based on a detection value of the light spot position detection sensor 103B.

[0091]

Further, as shown in FIG. 3, the projected luminous flux incident angle detection section 103 further comprises a projected luminous flux angle calculation section 103C, and the screen reflection surface deformation control section 106 comprises a screen deformation amount calculation section 106A and a screen reflection surface deformation operation section 106B.

[0092]

The above projected luminous flux angle calculation section 103C calculates the incident angle of the projected luminous flux on the screen reflection surface 108, according to value y detected from each of the light spot position detection sensors 103B, and outputs to the screen deformation amount calculation section 106A of the screen reflection surface deformation control section 106.

[0093]

The screen deformation amount calculation section 106A inputs the calculated data obtained from the projected luminous flux angle calculation section 103C, and according to

the light distribution angle information from the screen light distribution angle storage section 105 and observer covering area information from the observer covering area setting section 26, calculates an optimal deformation amount θ of the screen reflection surface 108, and inputs the optimal deformation amount θ to the screen reflection surface deformation operation section 106B.

[0094]

The above mentioned screen reflection surface deformation operation section 106B obtains an operation amount to deform the screen 101 in accordance with the input optimal deformation amount inputted from the screen deformation calculation section 106A, and outputs the operation amount to the screen reflection surface deformation driving section 107.

[0095]

Thus, according to this embodiment, it is possible to easily detect the angle of the projected luminous flux made incident on the screen reflection surface 108 by detecting the light spot position thereon.

[0096]

Moreover, a light distribution range of the luminous flux reflected on the screen reflection surface 108 is obtained based on the angle of the projected luminous flux made incident thereon, and the screen reflection surface 108 can be properly deformed to match the range with the area that covers the observers 3. Thus, it is possible to effectively condense the reflected luminous flux of the screen reflection surface 108 on the observers 3.

[0097]

Incidentally, as shown in FIG. 3, the reflection screen apparatus 100 of this embodiment may further comprise a deformation amount display section 109, a deformation pattern storage section 110, and a deformation pattern selection section 111.

[0098]

That is, the optimal deformation amount θ of the screen reflection surface obtained by the screen deformation amount calculation section 106A is also output to the deformation amount display section 109. Accordingly, the observers 3 can perceive the deformation amount. Typical deformation patterns of the screen reflection surface 108 can be stored in the deformation pattern storage section 110 in advance, and the observer 3 can select from the patterns by switch selection or the like at the deformation pattern selection section 111. When the observer 3 selects a deformation pattern by the deformation pattern selection section 111, the deformation pattern information is given to the screen reflection surface deformation operation section 106B, and the corresponding operation amount is obtained in the screen reflection surface deformation operation section 106B, and sent to the screen reflection surface deformation driving section 107. Further, the observer 3 may optionally select an easily seen deformation pattern.

[0099]

[Third Embodiment]

Next, the third embodiment of the present invention will

be explained. As in the case of the second embodiment, the third embodiment concerns deformation executed in accordance with the incident angle detection of the luminous flux by the projected luminous flux incident angle detection section 103.

[0100]

FIG. 4 (A) shows a constitution of a screen 101 according to the embodiment, and in the embodiment, a light amount detection sensor 103D is used in place of the light spot position detection sensor 103B of the second embodiment.

[0101]

Additionally, according to the embodiment, the projected luminous flux angle calculation section 103C of the projected luminous flux incident angle detection section 103 stores the relation between the detected light amount of the light amount detection sensor 103D and the incident angle of the projected luminous flux as foresighted information. Accordingly, the incident angle of the projected luminous flux can be easily obtained based on the detected light amount of the light amount detection sensor 103D. As a result, as in the case of the second embodiment, the angle of the projected luminous flux made incident on the screen reflection surface 108 can be calculated to be output to the screen deformation amount calculation section 106A of the screen reflection surface deformation control section 106.

[0102]

Thus, according to the embodiment, it is possible to easily detect the angle of the projected luminous flux made incident on the screen reflection surface 108.

[0103]

Moreover, a light distribution range of the reflected luminous flux on the screen reflection surface 108 is obtained based on the incident angle of the projected luminous flux thereon, and the screen reflection surface 108 can be properly deformed to match the range with the area that covers the observers 3. Thus, it is possible to effectively condense the reflected luminous flux of the screen reflection surface 108 on the observers 3.

[0104]

Incidentally, in place of the processing through the projected luminous flux angle calculation section 103C, the detected light amount of the light amount detection sensor 103D may be directly supplied to the screen deformation amount calculation section 106A of the screen reflection surface deformation control section 106. In this case, the screen deformation amount calculation section 106A stores the relation between the detected light amount and the deformation angle Ø of the screen reflection surface 108 which is similar to that shown in FIG. 4(B) as foresighted information, and Ø = Øx is preset as an optimal deformation angle of the screen reflection surface 108. Thus, the screen deformation amount calculation section 106A can calculate an optimal deformation amount of the screen reflection surface 108 based on a difference between the deformation angle corresponding to the detected light amount detected by the projected luminous flux incident angle detection section 103 and the optimal deformation angle Øx.

[0105]

[Fourth Embodiment]

Next, the fourth embodiment of the present invention will be explained below. The fourth embodiment concerns deformation control amount calculation of the screen reflection surface 108 by the screen reflection surface deformation control section 106.

[0106]

An estimation equation for deformation control amount calculation at the screen reflection surface deformation control section 106 will be described by referring to FIG. 5. This estimation equation is a setting example at a screen position P.

[0107]

Now, it is assumed that apexes of a virtual space which defines an observer covering area 401 set by the observer covering area setting section 104 are A, B, C and D. Additionally, it is assumed that an incident angle (angle formed with a normal direction of the screen reflection surface 108) of the projected light 42 detected by the projected luminous flux incident angle detection section 103 is α, a half of a maximum screen light distribution angle (defined by a kind of the screen 101, and stored in the screen light distribution angle memory section 105) is β, and an angle formed between a maximum light distribution boundary V1 (AP) and the horizontal reference line is γA. Then, an angle Ø of screen inclination (uppermost projected portion) that is a deformation control amount can be obtained by the following equation:

$\varnothing = \alpha - \beta + \gamma A$

[0108]

Incidentally, the "light distribution angle" means the diffusing and spreading angle thereof when light rays made incident on the screen 101 are reflected from the same spot of the screen reflection surface 108. The "maximum light distribution angle" means the angle formed between light rays of half-value brightness which sandwich a main reflection optical axis V of highest brightness among reflected lights from the same spot of the screen reflection surface 108. The "maximum light distribution boundary" means the position of the light rays of the half-value brightness. The "half-value brightness" is not necessarily a half value. The value may properly be defined based on a designing idea.

[0109]

Furthermore, in addition to the aforementioned example, matching of the maximum light distribution boundary V1 with one of the apexes of the virtual space that defines the observer covering area based on a relation between a size of the light distribution angle and a size of the observer covering area 401 may be decided on a case-by-case basis.

[0110]

Thus, it is possible to easily calculate a deformation control amount by using the estimation equation.

[0111]

[Fifth Embodiment]

Next, the fifth embodiment of the present invention will be explained below. The fifth embodiment concerns deformation

of the screen reflection surface 108 by the screen reflection surface deformation driving section 107.

[0112]

FIG. 6 (A) shows the deformation composition of the above noted screen reflection surface driving section 107, and FIG. 6(B) is the block composition diagram of the screen reflection surface deformation driving section 107.

[0113]

The screen 101 has spring characteristics, and is constituted to hold an erected spread state even if there is no special holding mechanism. Then, deformation wires 113 are passed through wire guides 112 arranged along both left and right ends of the screen 101. One end of each deformation wire 113 is fixed to an upper end position of the screen 101, while the other end side is fixed to a winding bobbin 115 attached to a rotary shaft of a rotary motor 114. The wire guide 112 allows free screen up-and-down movement of the deformation wire 113, but regulates screen left-and-right, and forward movement thereof within a predetermined range. Thus, the rotary motor 114 is rotated to wind the deformation wire 113 on the winding bobbin 115, whereby the screen upper end to which one end of the deformation wire 113 has been fixed is pulled downward to bend and deform the screen 101.

[0114]

Additionally, a photoelectric conversion means 116 is arranged near the lower end of the screen 101 to convert the projected light into power. The power obtained by the photoelectric conversion is stored in an electricity

accumulation means 117 to be used as a power supply for each section of the reflection screen apparatus which includes the screen reflection surface deformation control section 106.

[0115]

Thus, according to the embodiment, the light projected to the screen reflection surface 108 is converted into power by the photoelectric conversion means 116, and the power is used as a driving power supply for the mechanism of changing the light distribution direction state of the screen reflection surface 108. Therefore, there is no need to prepare another power supply for the mechanism of changing the light distribution direction state of the screen reflection surface 108, which contributes to energy saving.

[0116]

Incidentally, as shown in FIG. 6 (C), it is needless to say that the constitution of FIG. 6 (A) can be set upside down to be used as a screen of a ceiling suspension type.

[0117]

Furthermore, the screen deformation mechanism is not limited to the type that uses the deformation wires. Needless to say, for example, the present invention can be applied to various deformation mechanisms such as deformation by an extrusion mechanism from the back of the screen reflection surface to the projection apparatus side.

[0118]

[Sixth Embodiment]

Next, the sixth embodiment of the present invention will be explained below. The sixth embodiment is designed in such

a manner that a light amount is detected at a position of the observer 3 to accordingly deform the screen reflection surface 108.

[0119]

That is, a photodetection sensor is incorporated in a remote controller that is a remote operation member of the reflection screen apparatus. Then, as shown in FIG. 7, an amount of a reflected light from the screen 101 is measured by the remote controller 118 with the built-in photodetection sensor. Needless to say, the photodetection sensor should be set at a position in which the observer 3 can visually observe a projected image most brightly. Thus, as shown in FIG. 7, the observer 3 simply holds the remote controller with the built-in photodetection sensor by hand to set a state at the visual position.

[0120]

FIG. 8 is a functional block diagram showing a configuration in the case of using such a remote controller 118 with the built-in photodetection sensor.

[0121]

More specifically, as shown in the basic composition shown in FIG. 1 (B), the reflected light detection section 118A which is a photodetection sensor is provided to a light distribution correction means, in stead of the projected luminous flux incident angle detection section 103. Then, the reflected light detection section 118A and the operation section that includes the light distribution correction command section 102 or the like are arranged in the remote controller 118 with the

built-in photo-detection sensor. In this case, incidentally, the reflected light detection section 118A is connected to the screen reflection surface deformation control section 106 by wireless or the like.

[0122]

According to the above-described constitution, the observer 3 holds the remote controller 118 with the built-in photodetection sensor by hand to set the state at the visual position, and executes a predetermined key operation to issue a light distribution correction command from the light distribution correction command section 102. In accordance with the command, an image white on the full surface or a certain static image is projected from the projection apparatus 2. At the same time, the amount of a reflected light of the projected image on the screen reflection surface 108 is detected by the reflected light detection section 118A of the remote controller 118 with the built-in photodetection sensor. Subsequently, the result of the detection is transmitted to the screen reflection surface deformation control section 106 by wireless or the like. Thus, each section after the screen reflection surface deformation control section 106 executes the aforementioned operation to deform the screen reflection surface 108.

[0123]

Incidentally, if there are a plurality of observers 3, preferably, photodetection sensors are set at positions of all the observers to carry out detection in a time division manner, and a deformation amount of the screen reflection surface 108

is decided so that all difference values among obtained light amount signals can become minimum. That is, in the case of one observer 3, deformation control may be carried out so that the light amount detected by the photodetection sensor (reflected light detection section 118A) can take a maximum value. On the other hand, in the case of the plurality of observers 3, deformation control is carried out so that a difference between the detected light amounts can become minimum. This processing is for the purpose of preventing generation of a difference in brightness of the projected image among the target observers 3 as much as possible.

[0124]

According to the sixth embodiment, it is possible to surely condense the reflected luminous flux of the screen reflection surface in the area that includes (the plurality of) the observers by holding the photodetection sensor at (each) the observer or the like to set the position of (each) the photodetection sensor substantially identical to that of (each) the observer.

[0125]

Incidentally, the reflected light detection section 118A is incorporated in the remote controller 118 with the built-in photodetection sensor, and connected to the screen reflection surface deformation control section 106 by wireless or the like. Needless to say, however, the screen reflection surface deformation control section 106 may be incorporated in the remote controller 118 with the built-in photodetection sensor. In this case, the screen reflection surface

deformation control section 106, the screen reflection surface deformation driving section 107 and the image correction means 5 are interconnected by wireless or the like.

[0126]

[Seventh Embodiment]

Next, the seventh embodiment of the present invention will be described below. As opposed to the sixth embodiment, the seventh embodiment is designed in such a manner that a light is emitted from the position of the observer 3, the light is received at the position of the screen reflection surface 108 to detect the position of the observer, and an observer covering area is accordingly set to deform the screen reflection surface 108.

[0127]

That is, as shown in FIG. 9, a marker light spot position detection sensor 104A detects a luminous flux from a luminous body as a marker means that is incorporated in a remote controller 119 with a built-in marker, to thereby obtaining the position of an emission point by calculation. The marker light spot position detection sensor 104A generally comprises an image-forming lens and a light spot position sensor (not shown). In this example, the marker light spot position detection sensor 104A is arranged on a fixed screen lower part or the like of no relation to deformation so as to facilitate detection. If two sets of marker light spot position sensors 104A of such a constitution are arranged at a predetermined interval as shown in FIG. 10, it is possible to specify a spatial position of a marker light spot by using

a triangulation principle. Needless to say, the marker means should be set at a position in which the observer can visually observe the projected image most brightly, and the observer simply holds the marker to set a state at the visual position.

[0128]

Thus, the light emitted from the marker means is received to obtain a coordinate position thereof relative to the screen reflection surface 108, and the observer covering area 401 is set based on the obtained coordinate position. Therefore, it is possible to accurately set the observer covering area 401 in which the observer 3 is present. Additionally, in this case, a space that has a predetermined spatial spread including the detected marker coordinate may be set as an observer covering area. In this way, even if there are a plurality of observers around the marker position, the space that includes the plurality of observers can be set as an observer covering area. As a result, it is possible to surely condense the reflected luminous flux of the screen reflection surface on the plurality of observers.

[0129]

Needless to say, if there are a plurality of observers, marker means may be arranged at positions of all the observers in a time division manner to set the observer covering area 401. Alternatively, as shown in FIG. 10, marker means may be arranged at eight edge corners of a virtual space of the observer covering area 401 in a time division manner to set the same. Thus, it is possible to set the observer covering area 401 more accurately by setting the space surrounded with

a plurality of marker coordinates as the observer covering area 401.

[0130]

It goes without saying that the marker means is not limited to the type which uses a light, but may be a type which uses a generally used ultrasonic sound wave, electromagnetic wave or the like.

[0131]

[Eighth Embodiment]

Next, the eighth embodiment of the present invention will be described below.

[0132]

According to the third embodiment, the light amount is detected on the screen reflection surface 108 to detect the incident angle of the projected luminous flux, and the deformation amount of the screen reflection surface 108 is accordingly decided. On the other hand, according to the eighth embodiment, a light amount is detected while the screen reflection surface 108 is deformed, and a deformed state thereof is held when a predetermined light amount is obtained.

[0133]

That is, the micro-convex lens 103A for light condensation and the light amount detection sensor 103D are attached to the screen 101 in a relative positional relation in which a focusing point by the micro-convex lens 103A for light condensation is not matched with the light amount detection sensor 103D in a state before deformation as shown in FIG. 11(A), and matched therewith in a state after deformation

as shown in FIG. 11(B).

[0134]

According to such a constitution, when the screen reflection surface 108 is gradually deformed, and the focusing point by the projected light from the projection apparatus 2 is matched with the light amount detection sensor 103D at a predetermined position, deformation of an angle Ø has been achieved by this time in which a reflected light from the screen reflection surface 108 is directed to a predetermined observer covering area 401. Thus, it is only necessary to hold this deformed state.

[0135]

[Ninth Embodiment]

Next, the ninth embodiment of the present invention will be described follows.

[0136]

As shown in FIG. 12(A), there is known an apparatus in which the screen reflection surface 108 is constituted by two-dimensionally arranging a micro-lens 108A. Here, a reflection and diffusion area 108C surrounded with a light absorption area (black area) 108B is constituted on an image forming surface of the micro-lens 108A. On the screen reflection surface 108 of such a constitution, a light condensed in the reflection and diffusion area 108C by the micro-lens 108A is reflected and diffused therein to go out of the micro-lens 108A. On the other hand, a light condensed in the light absorption area 108B is absorbed therein.

[0137]

If the screen reflection surface 108 constituted by two-dimensionally arranging such a micro-lens 108A is applied to the present invention, and when the surface 108 is deformed as shown in FIG. 12(B) even the projected light absorbed in the light absorption area 108B can be focused on the reflection diffusion area 108C. Thus, the light is reflected and diffused by the reflection and diffusion area 108C to go out of the micro-lens 108A, and to be observed by the observer 3.

[0138]

Besides, there is no influence of an external light from a ceiling illumination lamp or the like since it is absorbed in the light absorption area 108B.

[0139]

In the micro-lens 108A, a wavelength selection reflection and diffusion film 108D shown in FIG. 13(A) may be constituted in place of the reflection diffusion area 108C. As shown in FIG. 13(B), the wavelength selection reflection and diffusion film 108D has characteristics of reflecting and diffusing only predetermined wavelengths, i.e., wavelengths R, G and B of the projected light, but not other light of a non-reflection wavelength area. Accordingly, even if the external light from the illumination lamp is condensed on a portion other than the light absorption area 108B, the light is not reflected/diffused, and thus a screen reflection surface 108 difficult to be influenced by the external light can be formed.

[0140]

Alternatively, in place of the micro-lens 108A equipped

with the wavelength selection reflection and diffusion film 108D, as shown in FIG. 14, a hologram filter 108E may be used which comprises wavelength selection reflection and diffusion film 108F in which areas are arrayed to individually reflect and diffuse R, G and B. That is, as shown, the hologram filter 108E can spatially separate focusing points by wavelengths as shown in the figure. Accordingly, if the wavelength selection reflection and diffusion film 108F in which the areas are arranged to reflect and diffuse the corresponding R, G and B wavelengths is constituted at a position of each focus, it is possible to obtain operational effects similar to those of the micro-lens 108A equipped with the wavelength selection reflection and diffusion film 108D shown in FIG. 13 (A).

[0141]

[Tenth Embodiment]

Next, the tenth embodiment of the present invention will be described below.

[0142]

Thus far, description has been made of one-dimensional deformation which deforms the upper end side of the screen reflection surface 108 toward the observer as the deformation direction thereof. However, the present invention is not limited to such. Needless to say, two-dimensional deformation may be carried out as indicated by θx, θy of FIG. 15.

[0143]

The two-dimensional deformation that bends the screen reflection surface 108 in a concave shape enables more effective condensation of the reflected luminous flux thereof

on the observer 3.

[0144]

[Eleventh Embodiment]

Next, the eleventh embodiment of the present invention will be described below.

[0145]

Thus far, description has been made of deformation of the entire screen reflection surface 108. However, the present invention is not limited to such. Needless to say, the screen reflection surface 108 may be locally deformed.

[0146]

That is, as shown in FIG. 16, the screen reflection surface 108 is constituted by arranging a plurality of micro-diffusion and reflection surfaces 108H on a screen base 108G. Thus, it is possible to change a state of a distribution direction of a light reflected on the screen reflection surface 108 by moving the micro-diffusion and reflection surfaces 108H.

[0147]

According to such a constitution, finer control can be carried out by micro-diffusion and reflection surface units.

[0148]

Some constitutional examples for moving the micro-diffusion and reflection surfaces 108H will be described.

[0149]

First, a charged film/thin film system will be described by referring to FIG. 17. FIG. 17 is an expanded view (equivalent view) of an A portion of FIG. 16, showing only one micro-diffusion and reflection surface 108H.

[0150]

That is, as shown in FIG. 17 (A), two fixed electrodes 108I are attached to the screen base 108G. Further, one side face of a charged movable plate 108J one surface of which is charged "+" and the other surface of which is charged "−" is attached between the fixed electrodes 108I. Then, the micro diffusion and reflection surface 108H is arranged on a free side face of the charged movable plate 108J. Additionally, one of the fixed electrodes 108I is connected through a switch 108K to a power source 108L, while the other is grounded.

[0151]

According to such a constitution, as shown in FIG. 17 (B), at the time of transition to deformation, the switch 108K is turned on to apply "+" to the fixed electrode 108I opposite the "+" charged side of the charged movable plate 108J. Accordingly, the charged movable plate 108J is deformed by repulsion of charges, which is accompanied by a change in inclination angle of the micro-diffusion and reflection surface 108H. Then, when a desired angle is reached, the switch 108K is turned off to hold the deformed state, as shown in FIG. 17 (C).

[0152]

FIG. 18 is a view showing a constitution in the case of a charged rotary plate system. The drawing is also an expanded view (equivalent view) of the A portion of FIG. 16, showing only one micro-diffusion and reflection surface 108H.

[0153]

More specifically, as shown in FIG. 18 (A), a charged

rotary plate 108M that has a surface to become the micro-diffusion and reflection surface 108H is rotatably attached in the screen base 108G. One side face of the charged rotary plate 108M is charged "+", while the other side face is charged "-". Then, three fixed electrodes 108I1, and three fixed electrodes 108I2 are disposed on the screen base 108G sandwiching the charged rotary plate 108M. In this case, the fixed electrode 108I2 that becomes an observer side is constituted as a transparent electrode. The three fixed electrodes 108I1 are selectively connected through a switch 108K1 to the power source 108L, while the three fixed electrodes 108I2 are selectively grounded through a switch 108K2. The switches 108K1 and 108K2 are linked with each other. However, the fixed electrodes 180I1, 108I2 and the switches 108K1, 108K2 are connected so that uppermost one of the three fixed electrodes 108I1 and lowermost one of the three fixed electrodes 108I2 can be simultaneously selected, middle one of the fixed electrodes 108I1 and middle one of the fixed electrodes 108I2 can be simultaneously selected, and lowermost one of the fixed electrodes 108I1 and uppermost one of the fixed electrodes 108I2 can be simultaneously selected.

[0154]

Thus, according to such a constitution, as shown in FIG. 18 (B), at the time of transition to deformation, the switch 108K1 is switched to set a state of connecting the lowermost fixed electrode K1 to the power source 108L, while the switch 108K2 is switched to set a state of grounding the uppermost fixed electrode K2. Then, the "-" charged side face

of the charged rotary plate 108M is pulled to the lowermost fixed electrode K1 side, while the "+" charged side face is pulled to the uppermost fixed electrode K2 side. Accordingly, the charged rotary plate 108M is rotated to change the inclination angle of the micro-diffusion and reflection surface 108H. Then, as shown in FIG. 8 (C), when a desired angle is reached, the switches 108K1, and 108K2 are both turned off to hold the deformed state.

[0155]

As a result, it is possible to hold the deformation of the micro-diffusion and reflection surface 108H by an electrostatic force.

[0156]

Incidentally, the photoelectric conversion means 116 and the electricity accumulation means 117 described above with reference to the fifth embodiment may be used in place of the power source 108L. A constitution in such a case is shown in FIGS. 19 and 20.

[0157]

[Twelfth Embodiment]

Next, the twelfth embodiment of the present invention will be described below. The embodiment is applied to a screen of a curtain type.

[0158]

Then, as shown in FIG. 21, the screen 101 is formed in a dual structure of a curtain 120 and a screen reflection surface 108. Then, the curtain 120 and screen reflection surface 108 are folded together to be housed, and the screen

reflection surface 108 is expanded in a drawn state of the curtain 120. Thus, only the screen reflection surface 108 is deformed to enable effective condensation of a reflected luminous flux thereof on the observers 3.

[0159]

As described above, the present invention is explained according to the embodiments, however, the present invention is not limited to the embodiments noted above, and it can be taken as a matter of course that various deformations and applications can be made within the scope of the present invention.

[0160]

[Advantage of the Invention]

As described above in detail, the present invention can provide a reflection screen apparatus that can adaptively correct a light distribution on a screen reflection surface in accordance with an angle of a projected luminous flux made incident on the screen reflection surface, reflected light distribution characteristics thereof, and a set state of an area which covers an observer for whom reflected light is condensed, and effectively condense the reflected luminous flux of the screen reflection surface for the observer, and a projection system using the same.

[0161]

Namely, since the screen reflection surface is adaptively deformed, to enable effective condensation of a reflected luminous flux of the projected luminous flux on the screen reflection surface, the projected image can be properly adapted

to the observing environment irrespective of the installed place of the projection apparatus and the screen, and the position in which the observer is present, and it is possible to reduce the reflected light as much as possible to the area where the observer does not exist, and to effectively provide the reflected light amount only to the observer. Accordingly, not simply enlarging the projection light amount of the projection apparatus, the projected image reflected in a flexible and effective way creates a very bright state, which enables the observer to enjoy an projected image brighter and easier to observe.

[Brief Description of the Drawings]

[FIG. 1]

(A) A view showing a sate of using a reflection screen apparatus according to a first embodiment of the present invention, and a projection system that uses the same.

(B) A functional block diagram showing a basic configuration of the projection system according to the first embodiment.

[FIG. 2]

A view showing a constitution of a screen according to a second embodiment of the present invention.

[FIG. 3]

A functional block diagram showing a constitution for detecting a projected luminous flux incident angle.

[FIG. 4]

(A) A view showing a constitution of a screen according to a third embodiment of the present invention.

(B) A view showing a relation between an amount of a detected light and a deformation angle of a screen reflection surface.

[FIG. 5]

A view explaining each parameter in an estimation equation for calculating an amount of deformation control at a screen reflection surface deformation control section according to the fourth embodiment of the present invention.

[FIG. 6]

(A) A view showing a deformation mechanism of a screen reflection surface deformation driving section according to a fifth embodiment of the present invention.

(B) A block constitutional diagram of the screen reflection surface deformation driving section.

(C) A view showing a constitution in the case of ceiling suspension.

[FIG. 7]

A view showing a state of using a remote controller with a built-in photodetection sensor for explaining position measurement of an observer who uses the remote controller with the built-in photodetection sensor according to a sixth embodiment of the present invention.

[FIG. 8]

A functional block diagram showing a configuration of a projection system that uses the remote controller with the built-in photodetection sensor.

[FIG. 9]

A view showing a state of using a remote controller with

a built-in marker for explaining setting of an observer covering area which uses the remote controller with the built-in marker according to a seventh embodiment of the present invention.

[FIG. 10]

A view explaining a relation between a position of the remote controller with the built-in marker and the observer covering area.

[FIG. 11]

A view showing a state before deformation for explaining a positional relation between a micro-convex lens for light condensation and a light amount detection sensor according to an eighth embodiment of the present invention.

[FIG. 12]

A view explaining a constitution of a screen reflection surface according to a ninth embodiment of the present invention.

[FIG. 13]

(A) A view showing a constitution of a micro-lens and (B) is a view explaining characteristics of a light absorption area.

[FIG. 14]

A view showing a constitution of a screen reflection surface in the case of using a hologram filter.

[FIG. 15]

A view explaining a deformation direction of a screen reflection surface according to a tenth embodiment of the present invention.

[FIG. 16]

A view explaining a constitution of a screen reflection surface according to an eleventh embodiment of the present invention.

[FIG. 17]

An expanded view (equivalent view) of an A portion of FIG. 16 in the case of a charged film/thin plate system.

[FIG. 18]

An expanded view (equivalent view) of the A portion of FIG. 16 in the case of a charged rotary plate system.

[FIG. 19]

A view showing a modified example of a constitution of FIG. 17 in the case of using a photoelectric conversion means and an electricity accumulation section.

[FIG. 20]

A view showing a modified example of a constitution of FIG. 18 in the case of using a photoelectric conversion means and an electricity accumulation means.

[FIG. 21]

A view explaining a constitution of a screen according to a twelfth embodiment of the present invention.

[Explanation of Reference Symbols]

2 … Projection apparatus,

3 … Observers,

4 … Observation area,

5 … Image correction means,

100 … Reflection screen apparatus,

101 … Screen,

102 … Light distribution correction command section,

103 … Projected luminous flux incident angle detection section,

103A … Micro-convex lens for light condensation,

103B … Light spot position detection sensor,

103C … Projected luminous flux angle calculation section,

103D … Light amount detection sensor,

104 … Observer covering area setting section,

104A … Marker light spot position detection sensor,

105 … Screen light distribution angle storage section,

106 … Screen reflection surface deformation control section,

106A … Screen deformation amount calculating section,

106B … Screen reflection surface deformation operation section,

107 … Screen reflection surface deformation driving section,

108 … Screen reflection surface,

108A … Micro-lens,

108B … Light absorption area,

108C … Reflection and diffusion area,

108D, 108F … Wavelength selection reflection and diffusion film,

108E … Hologram filter,

108H … Micro-diffusion and reflection surface,

108G … Screen base,

108I, 108I1, 108I2 … Fixed electrode,

108J … Charged movable plate,

108K, 108K1, 108K2 … Switch,

108L … Power,

108M … Charged rotary plate,

109 … Deformation amount display section,

110 … Deformation pattern storage section,

111 … Deformation pattern selection section,

112 … Wire guide,

113 … Deformation wire,

114 … Rotary motor,

115 … Winding bobbin,

116 … Photoelectric conversion means,

117 … Electricity accumulation means,

118 … Remote controller with built-in photodetection sensor,

118A … Reflected light detection section,

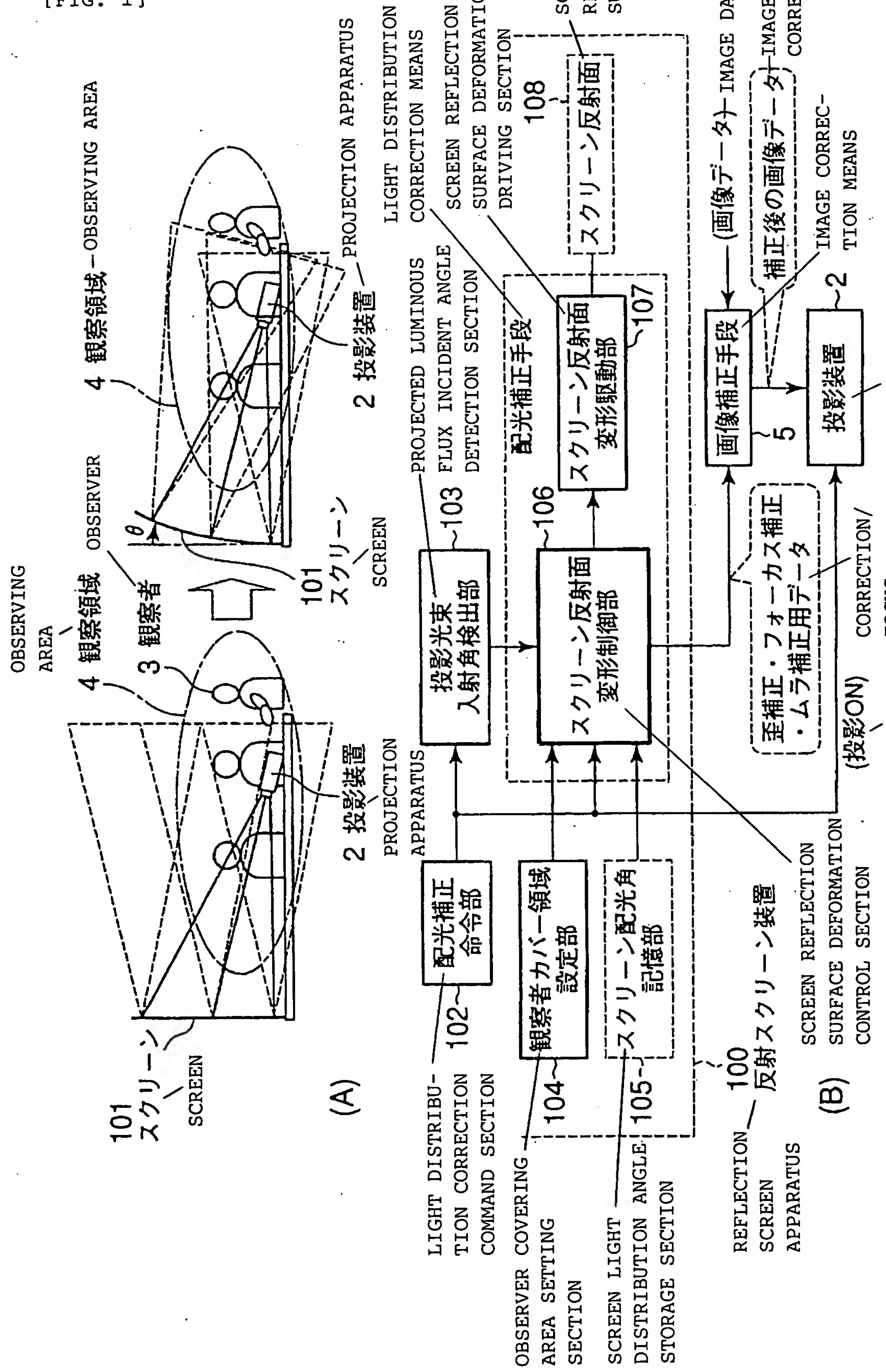
119 … Marker built-in remote controller,

120 … Curtain,

401 … Observer covering area.

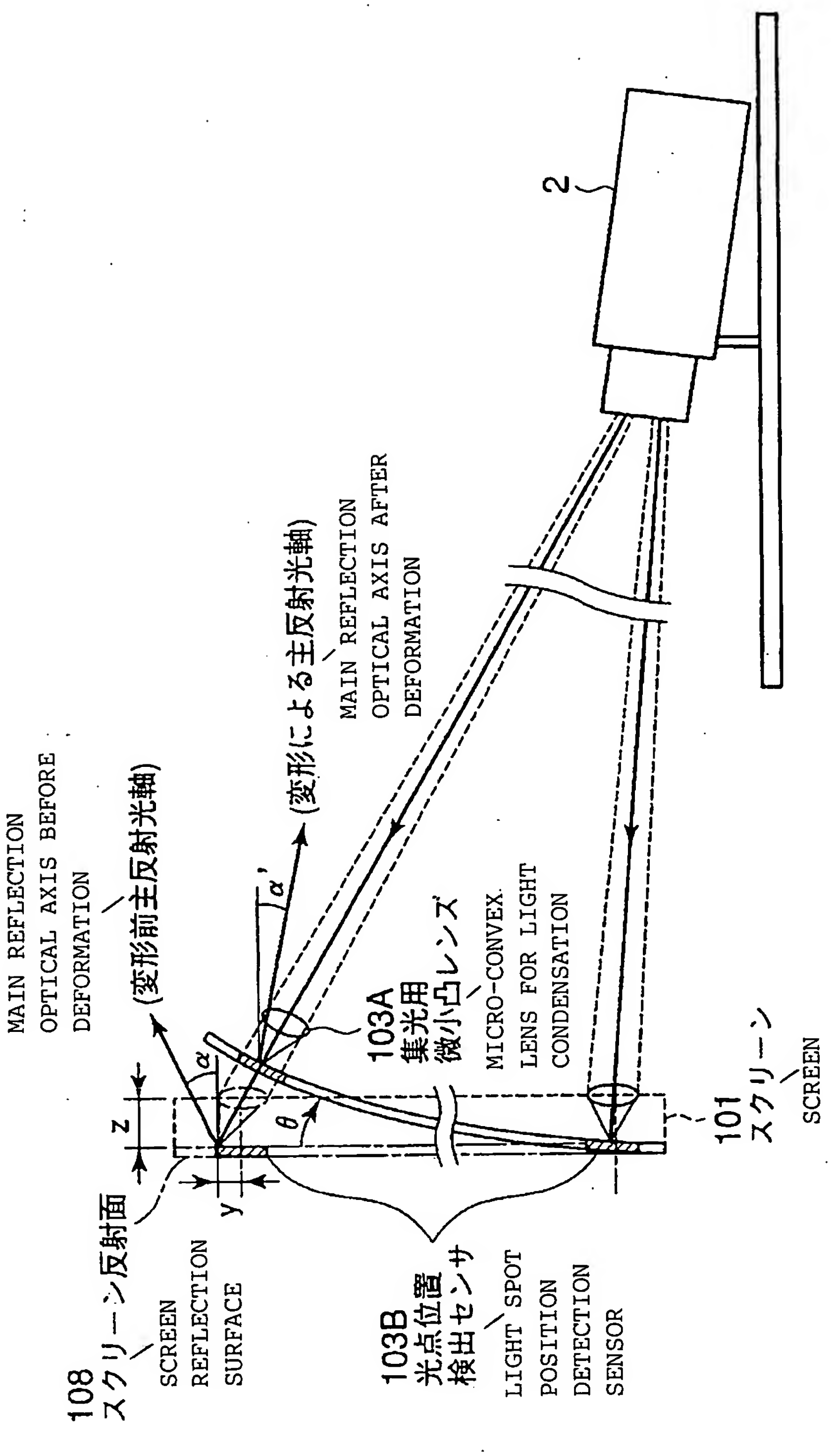
【書類名】 図面
[NAME OF DOCUMENT] DRAWINGS

【図１】
[FIG. 1]



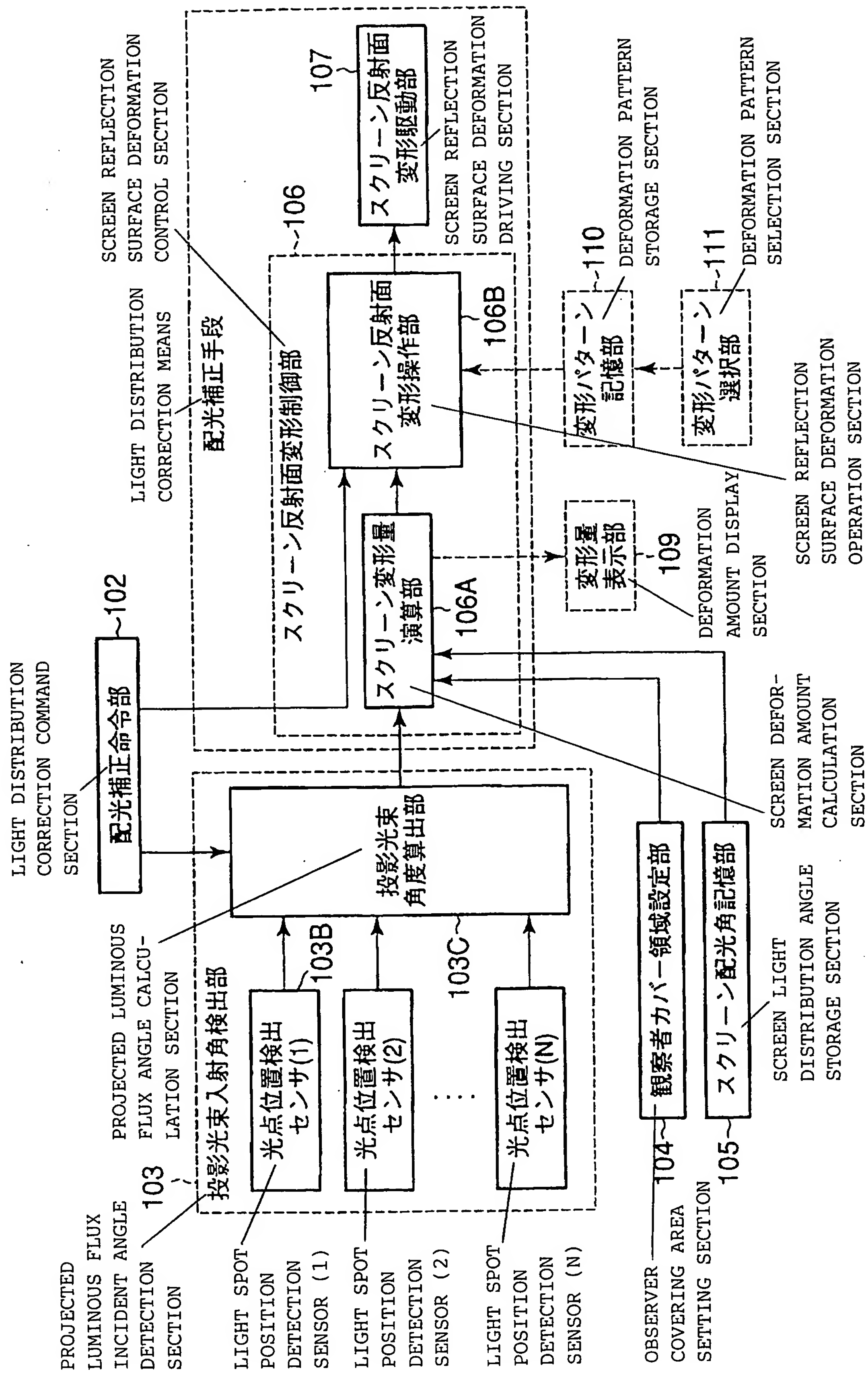
【図２】

[FIG. 2]



2
(変形による主反射光軸)
MAIN REFLECTION OPTICAL AXIS AFTER DEFORMATION
MAIN REFLECTION OPTICAL AXIS BEFORE DEFORMATION
(変形前主反射光軸)
α'
α
θ
z
y
103A
集光用
微小凸レンズ
MICRO-CONVEX LENS FOR LIGHT CONDENSATION
101
スクリーン
SCREEN
108
スクリーン反射面
SCREEN REFLECTION SURFACE
103B
光点位置
検出センサ
LIGHT SPOT POSITION DETECTION SENSOR

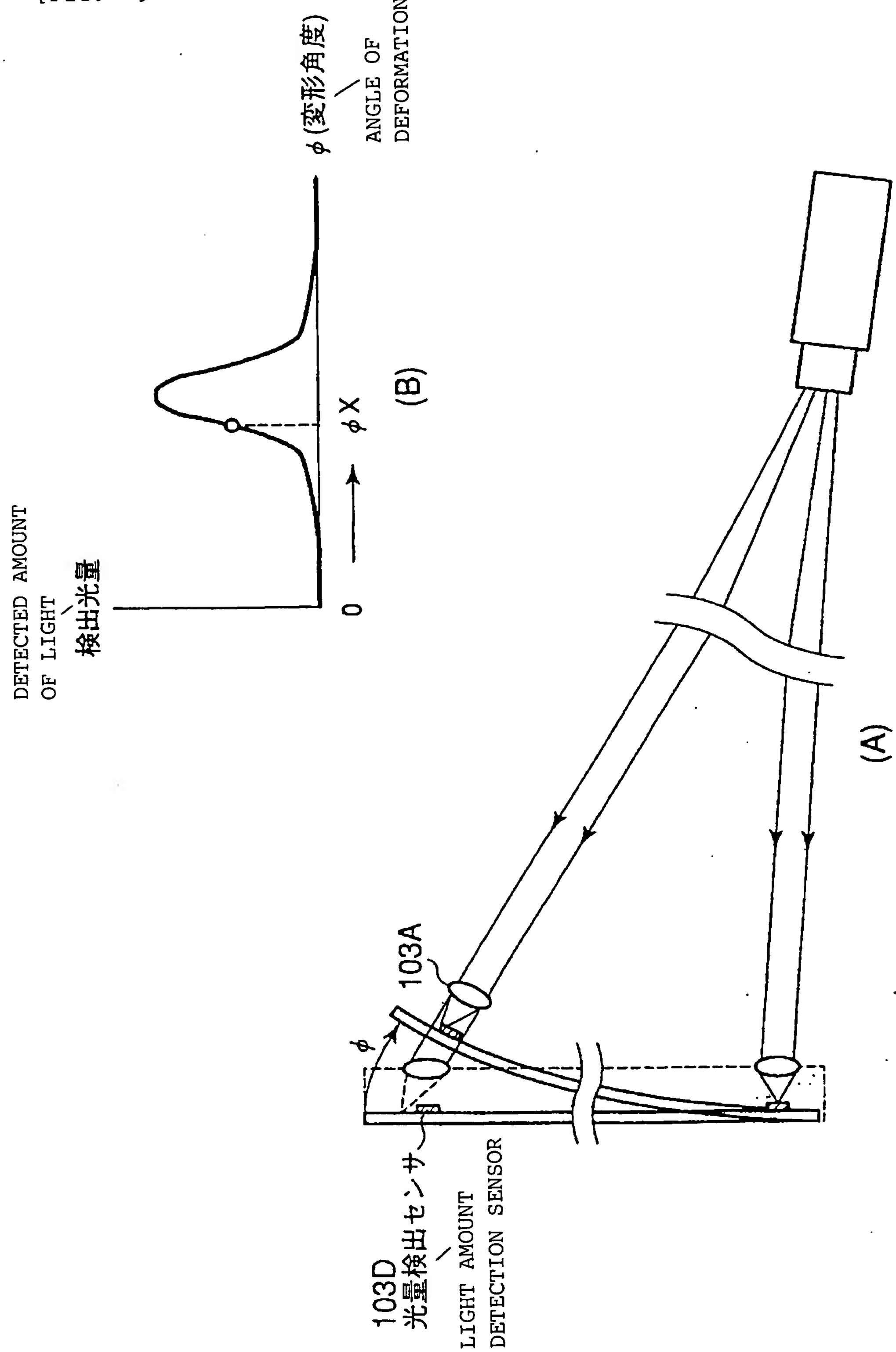
【図3】
[FIG. 3]



PROJECTED LUMINOUS FLUX INCIDENT ANGLE DETECTION SECTION
103
投影光束入射角検出部
光点位置検出センサ(1)
LIGHT SPOT POSITION DETECTION SENSOR (1)
光点位置検出センサ(2)
LIGHT SPOT POSITION DETECTION SENSOR (2)
光点位置検出センサ(N)
LIGHT SPOT POSITION DETECTION SENSOR (N)
103B
103C
PROJECTED LUMINOUS FLUX ANGLE CALCULATION SECTION
投影光束角度算出部
LIGHT DISTRIBUTION CORRECTION COMMAND SECTION
配光補正命令部
102
観察者カバー領域設定部
104
OBSERVER COVERING AREA SETTING SECTION
スクリーン配光角記憶部
105
SCREEN LIGHT DISTRIBUTION ANGLE STORAGE SECTION
SCREEN DEFORMATION AMOUNT CALCULATION SECTION
スクリーン変形量演算部
106A
LIGHT DISTRIBUTION CORRECTION MEANS
配光補正手段
SCREEN REFLECTION SURFACE DEFORMATION CONTROL SECTION
スクリーン反射面変形制御部
106
スクリーン反射面変形操作部
106B
SCREEN REFLECTION SURFACE DEFORMATION OPERATION SECTION
スクリーン反射面変形駆動部
107
SCREEN REFLECTION SURFACE DEFORMATION DRIVING SECTION
変形量表示部
109
DEFORMATION AMOUNT DISPLAY SECTION
変形パターン記憶部
110
DEFORMATION PATTERN STORAGE SECTION
変形パターン選択部
111
DEFORMATION PATTERN SELECTION SECTION

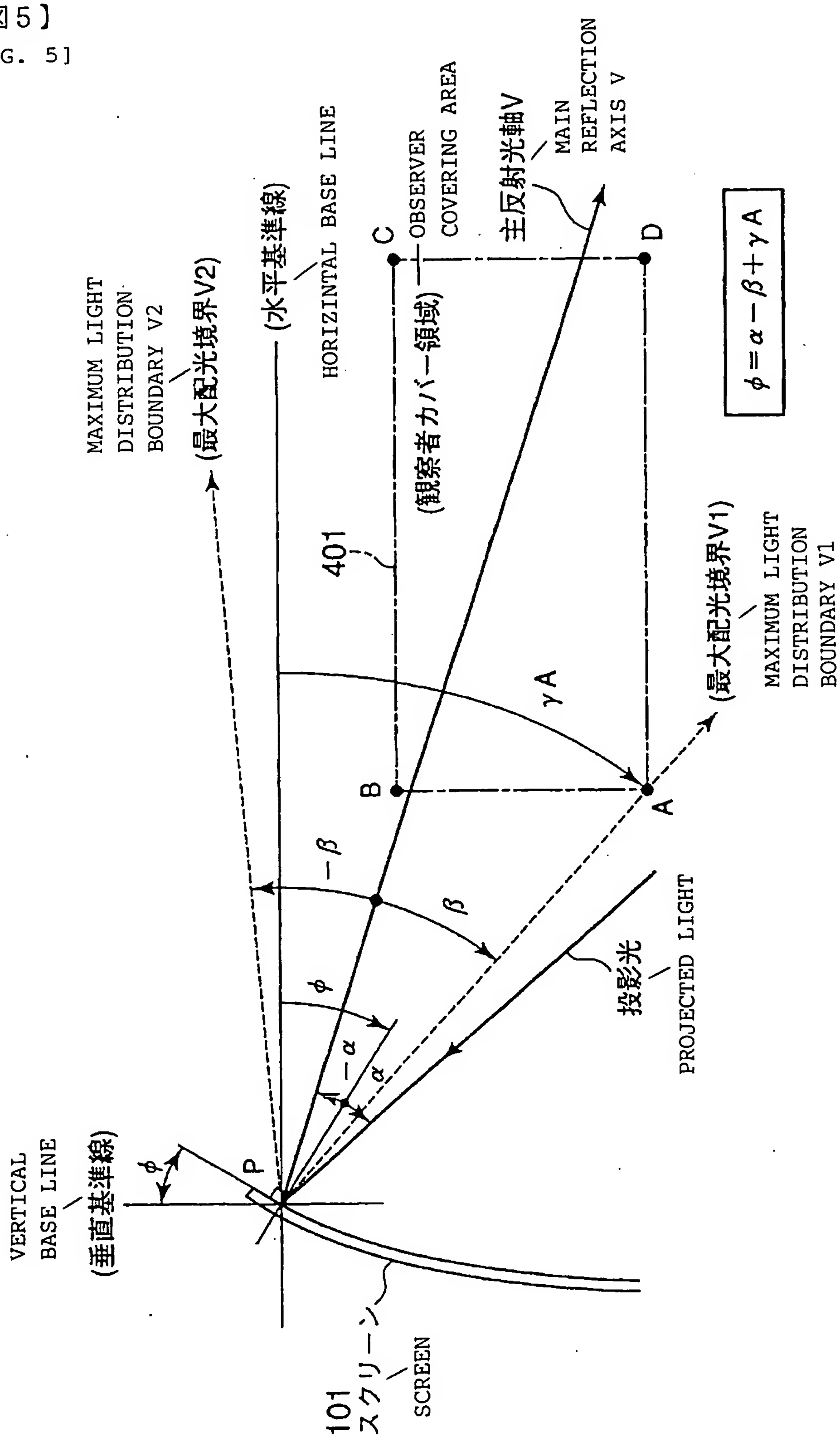
【図4】

[FIG. 4]



検出光量
DETECTED AMOUNT
OF LIGHT
0
φX
φ(変形角度)
ANGLE OF
DEFORMATION
(B)
(A)
103A
φ
103D
光量検出センサ
LIGHT AMOUNT
DETECTION SENSOR

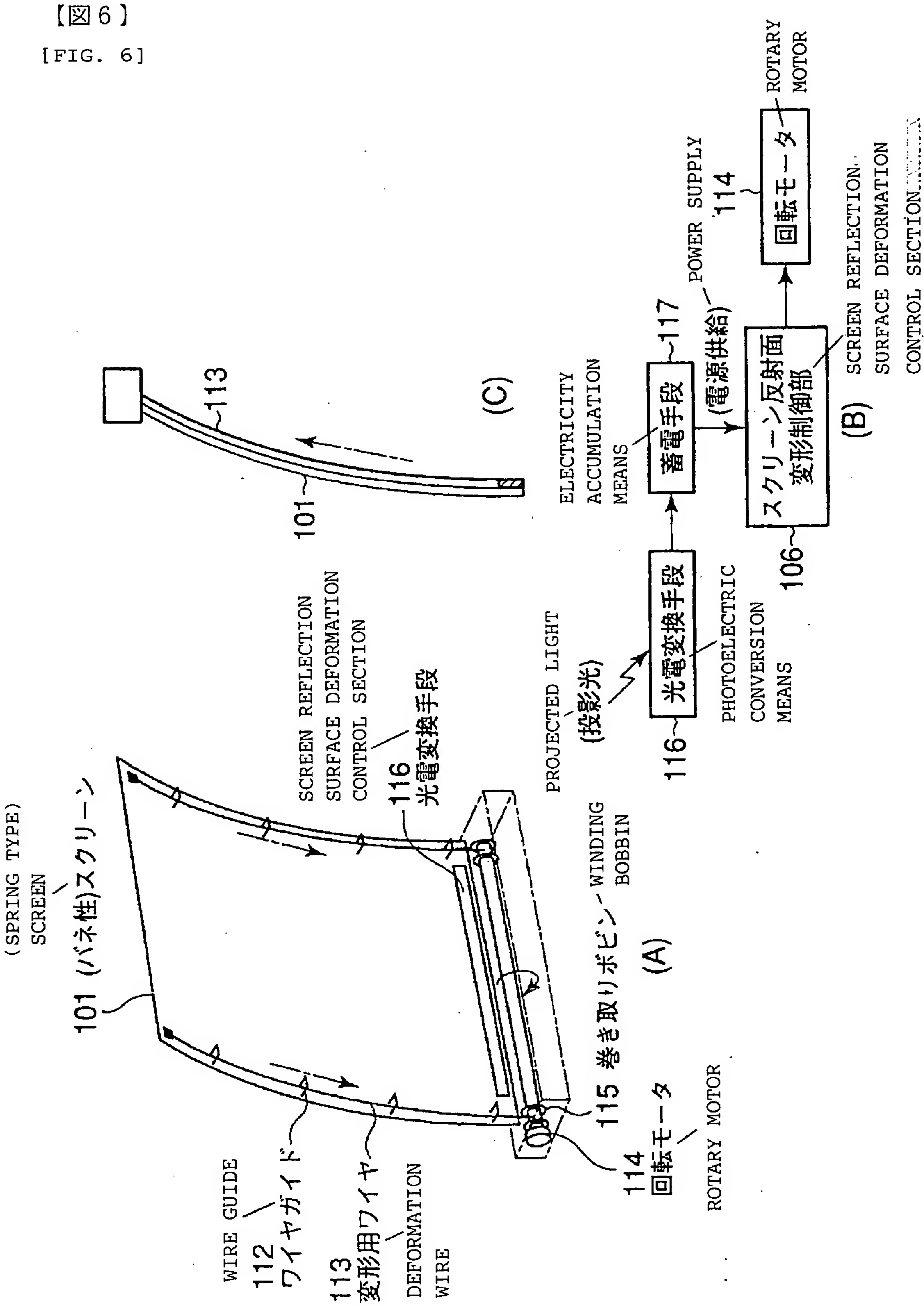
【図5】
[FIG. 5]



最大配光境界V2
MAXIMUM LIGHT DISTRIBUTION BOUNDARY V2
(水平基準線)
HORIZINTAL BASE LINE
観察者カバー領域
OBSERVER COVERING AREA
主反射光軸V
MAIN REFLECTION AXIS V
C
D
$\phi = \alpha - \beta + \gamma A$
401
最大配光境界V1
MAXIMUM LIGHT DISTRIBUTION BOUNDARY V1
γA
B
A
$-\beta$
β
ϕ
$-\alpha$
α
投影光
PROJECTED LIGHT
P
垂直基準線
VERTICAL BASE LINE
101
スクリーン
SCREEN

【図6】

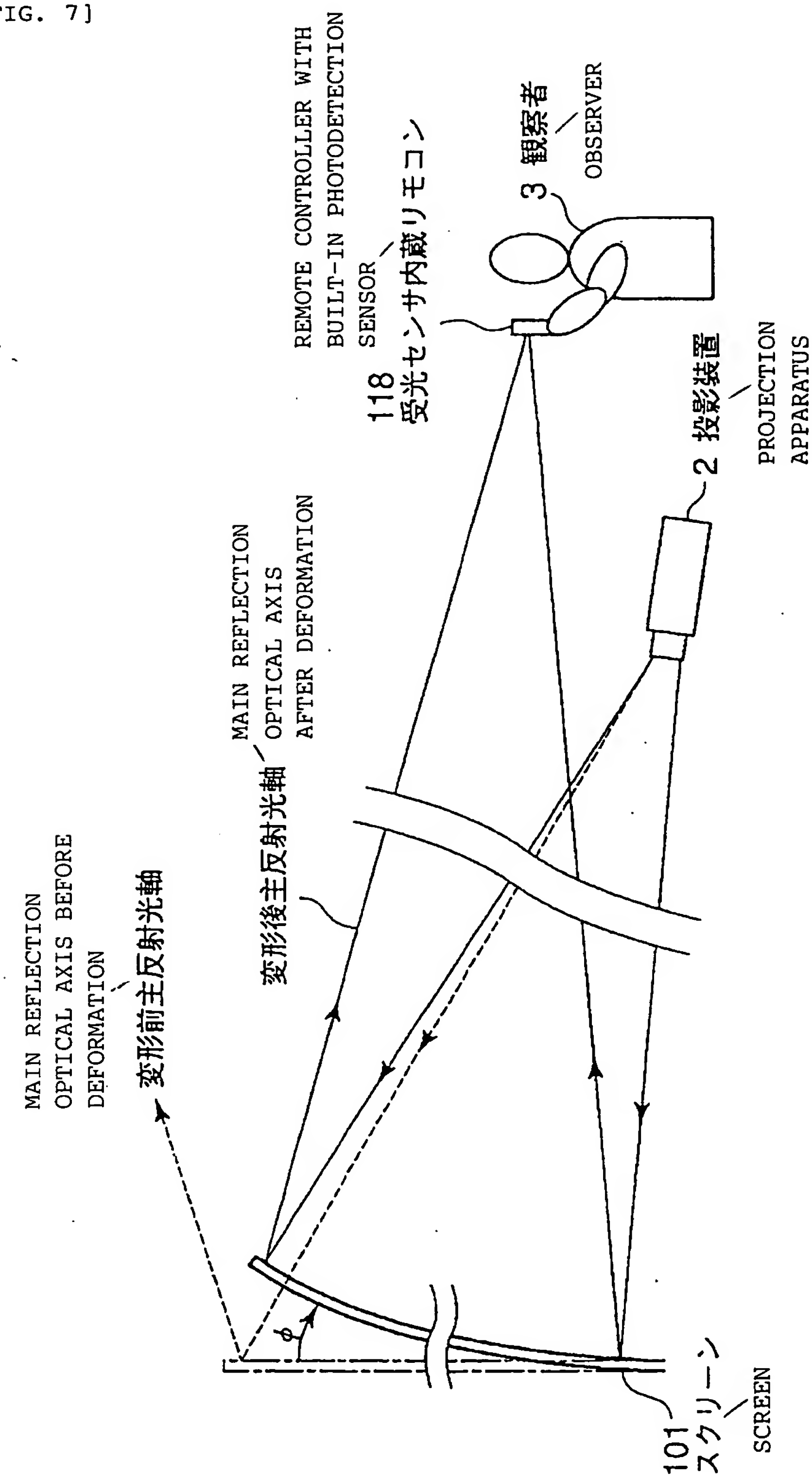
[FIG. 6]



101 (バネ性)スクリーン
(SPRING TYPE) SCREEN
112 ワイヤガイド
WIRE GUIDE
113 変形用ワイヤ
DEFORMATION WIRE
114 回転モータ
ROTARY MOTOR
115 巻き取りボビン
WINDING BOBBIN
116 光電変換手段
SCREEN REFLECTION SURFACE DEFORMATION CONTROL SECTION
(A)
113
101
(C)
PROJECTED LIGHT
(投影光)
116 光電変換手段
PHOTOELECTRIC CONVERSION MEANS
ELECTRICITY ACCUMULATION MEANS
蓄電手段 117
(電源供給)
POWER SUPPLY
106 スクリーン反射面変形制御部
SCREEN REFLECTION SURFACE DEFORMATION CONTROL SECTION
114 回転モータ
ROTARY MOTOR
(B)

【図7】

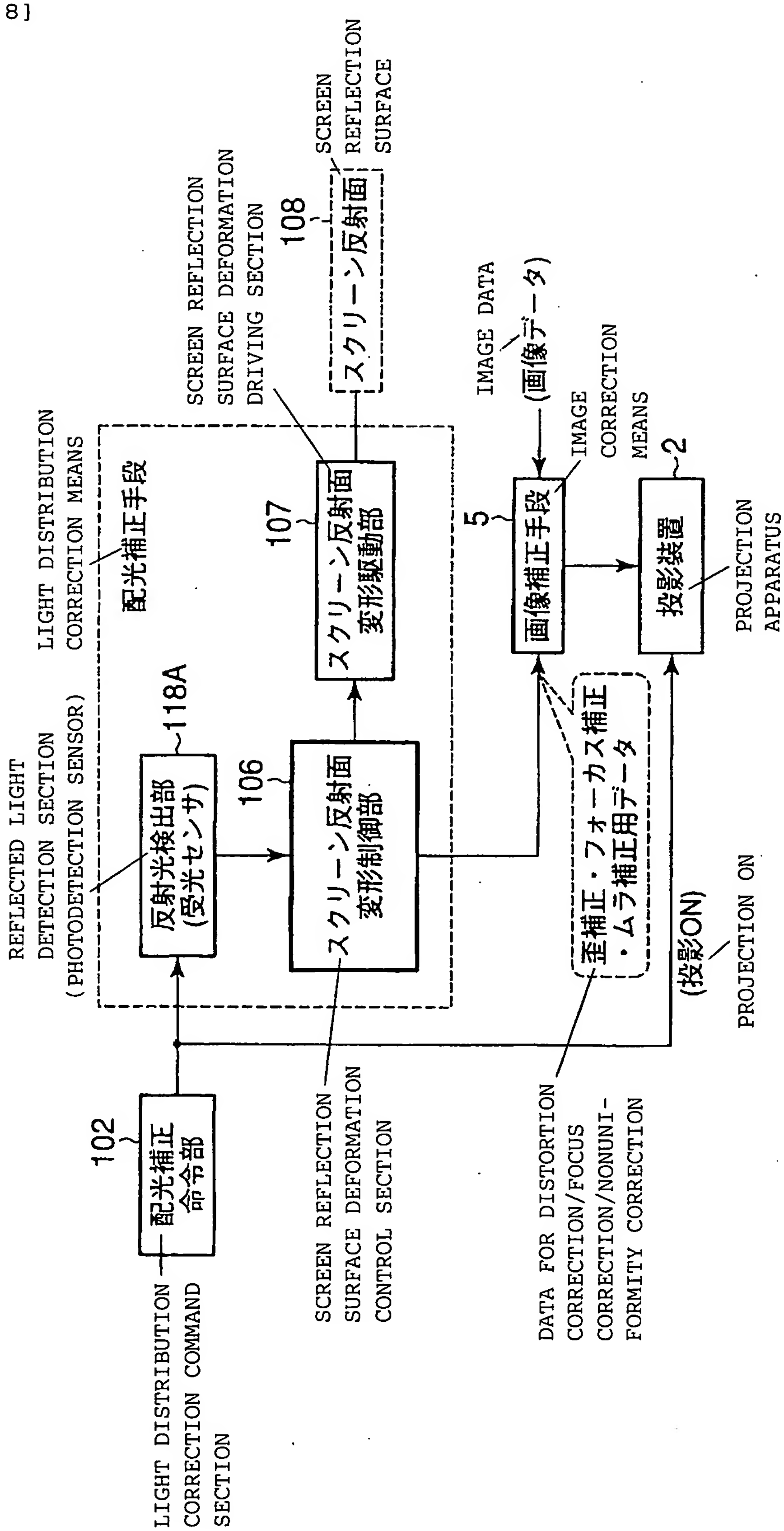
[FIG. 7]



REMOTE CONTROLLER WITH BUILT-IN PHOTODETECTION SENSOR
118 受光センサ内蔵リモコン
3 観察者
OBSERVER
2 投影装置
PROJECTION APPARATUS
MAIN REFLECTION OPTICAL AXIS AFTER DEFORMATION
変形後主反射光軸
MAIN REFLECTION OPTICAL AXIS BEFORE DEFORMATION
変形前主反射光軸
φ
101 スクリーン
SCREEN

【図8】

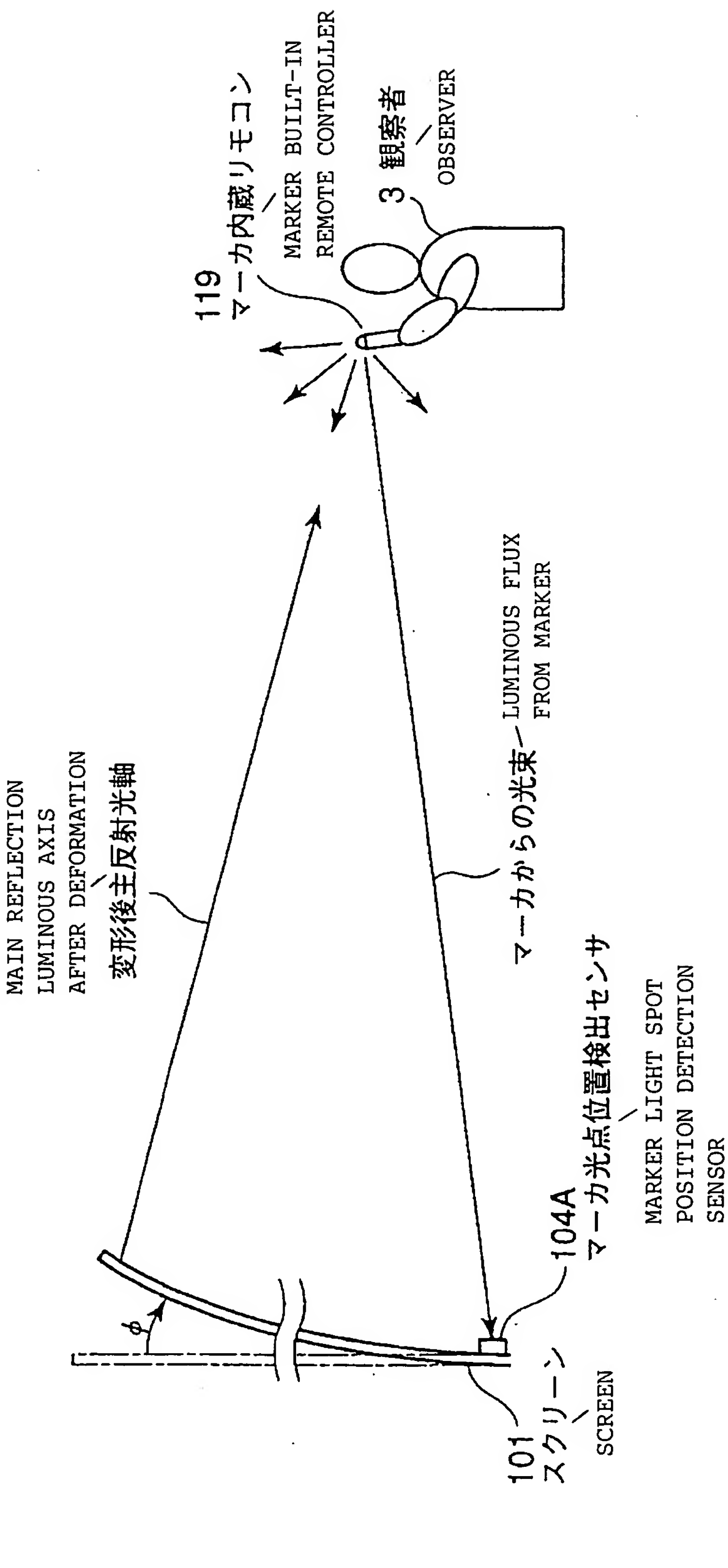
[FIG. 8]



配光補正命令部
102
LIGHT DISTRIBUTION CORRECTION COMMAND SECTION
反射光検出部（受光センサ）
118A
REFLECTED LIGHT DETECTION SECTION (PHOTODETECTION SENSOR)
配光補正手段
LIGHT DISTRIBUTION CORRECTION MEANS
スクリーン反射面変形制御部
106
SCREEN REFLECTION SURFACE DEFORMATION CONTROL SECTION
スクリーン反射面変形駆動部
107
SCREEN REFLECTION SURFACE DEFORMATION DRIVING SECTION
スクリーン反射面
108
SCREEN REFLECTION SURFACE
(画像データ)
IMAGE DATA
画像補正手段
5
IMAGE CORRECTION MEANS
投影装置
2
PROJECTION APPARATUS
歪補正・フォーカス補正・ムラ補正用データ
DATA FOR DISTORTION CORRECTION/FOCUS CORRECTION/NONUNIFORMITY CORRECTION
(投影ON)
PROJECTION ON

【図9】

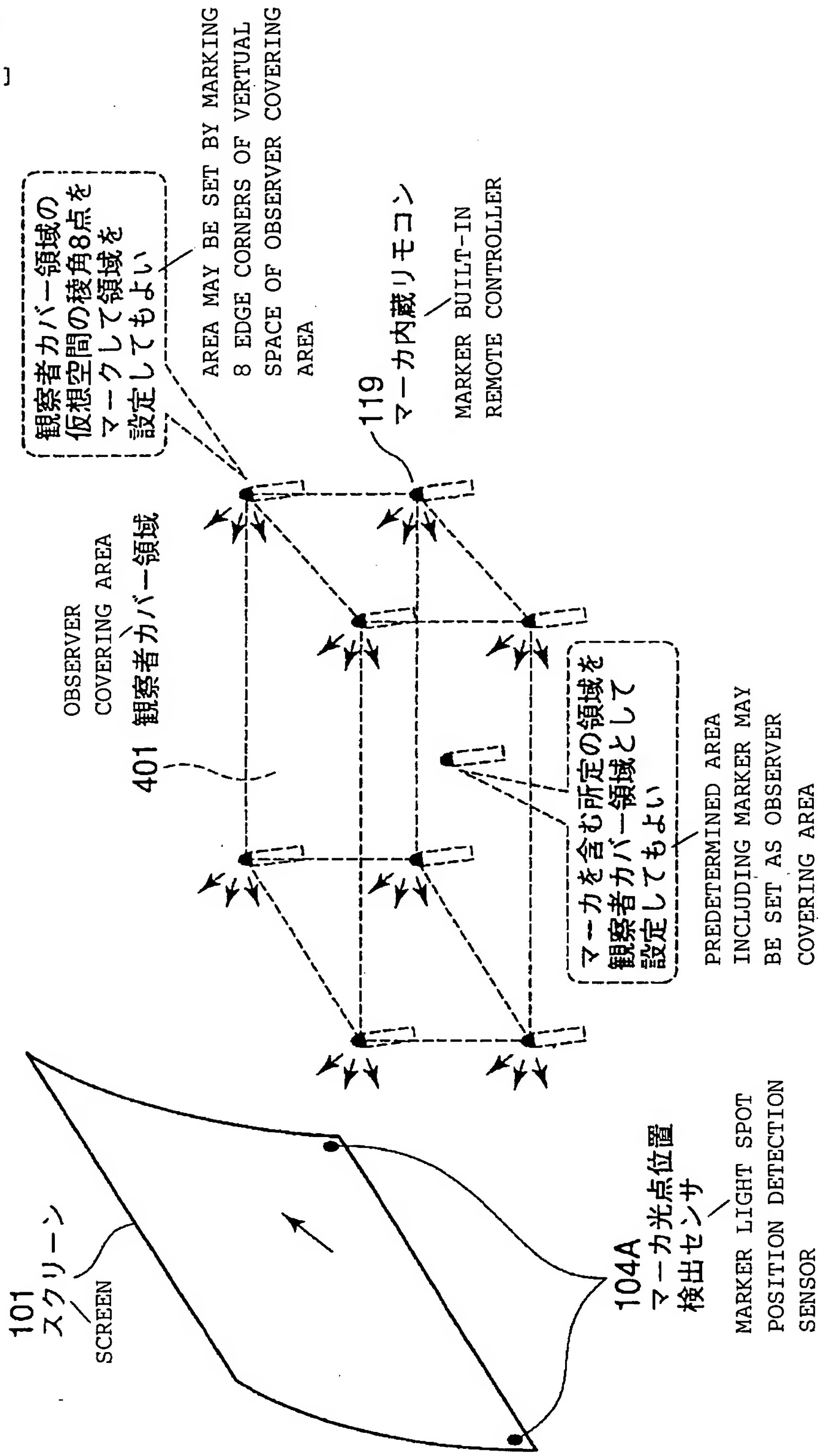
[FIG. 9]



119
マーカ内蔵リモコン
MARKER BUILT-IN REMOTE CONTROLLER
3 観察者
OBSERVER
MAIN REFLECTION LUMINOUS AXIS AFTER DEFORMATION
変形後主反射光軸
マーカからの光束
LUMINOUS FLUX FROM MARKER
104A
マーカ光点位置検出センサ
MARKER LIGHT SPOT POSITION DETECTION SENSOR
φ
101
スクリーン
SCREEN

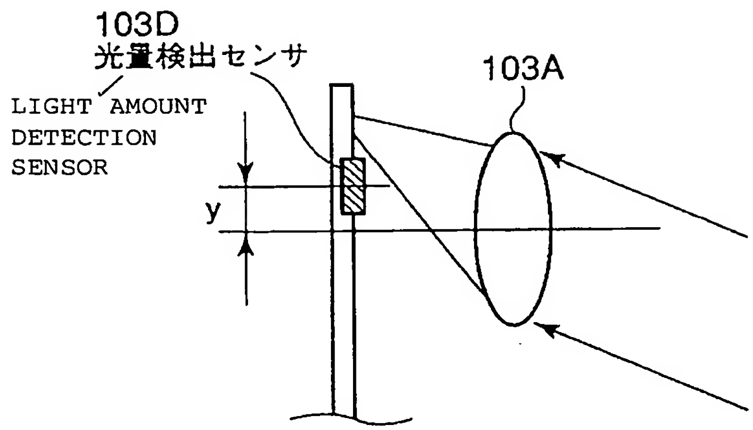
【図１０】

[FIG. 10]


観察者カバー領域の仮想空間の稜角8点をマークして領域を設定してもよい
AREA MAY BE SET BY MARKING 8 EDGE CORNERS OF VERTUAL SPACE OF OBSERVER COVERING AREA
119
マーカ内蔵リモコン
MARKER BUILT-IN REMOTE CONTROLLER
OBSERVER COVERING AREA
401 観察者カバー領域
マーカを含む所定の領域を観察者カバー領域として設定してもよい
PREDETERMINED AREA INCLUDING MARKER MAY BE SET AS OBSERVER COVERING AREA
101
スクリーン
SCREEN
104A
マーカ光点位置検出センサ
MARKER LIGHT SPOT POSITION DETECTION SENSOR

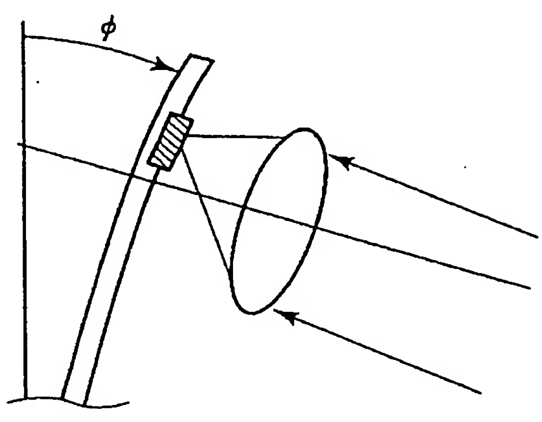
【図１１】

[FIG. 11]



STATE BEFORE DEFORMATION 変形前の状態

(A)

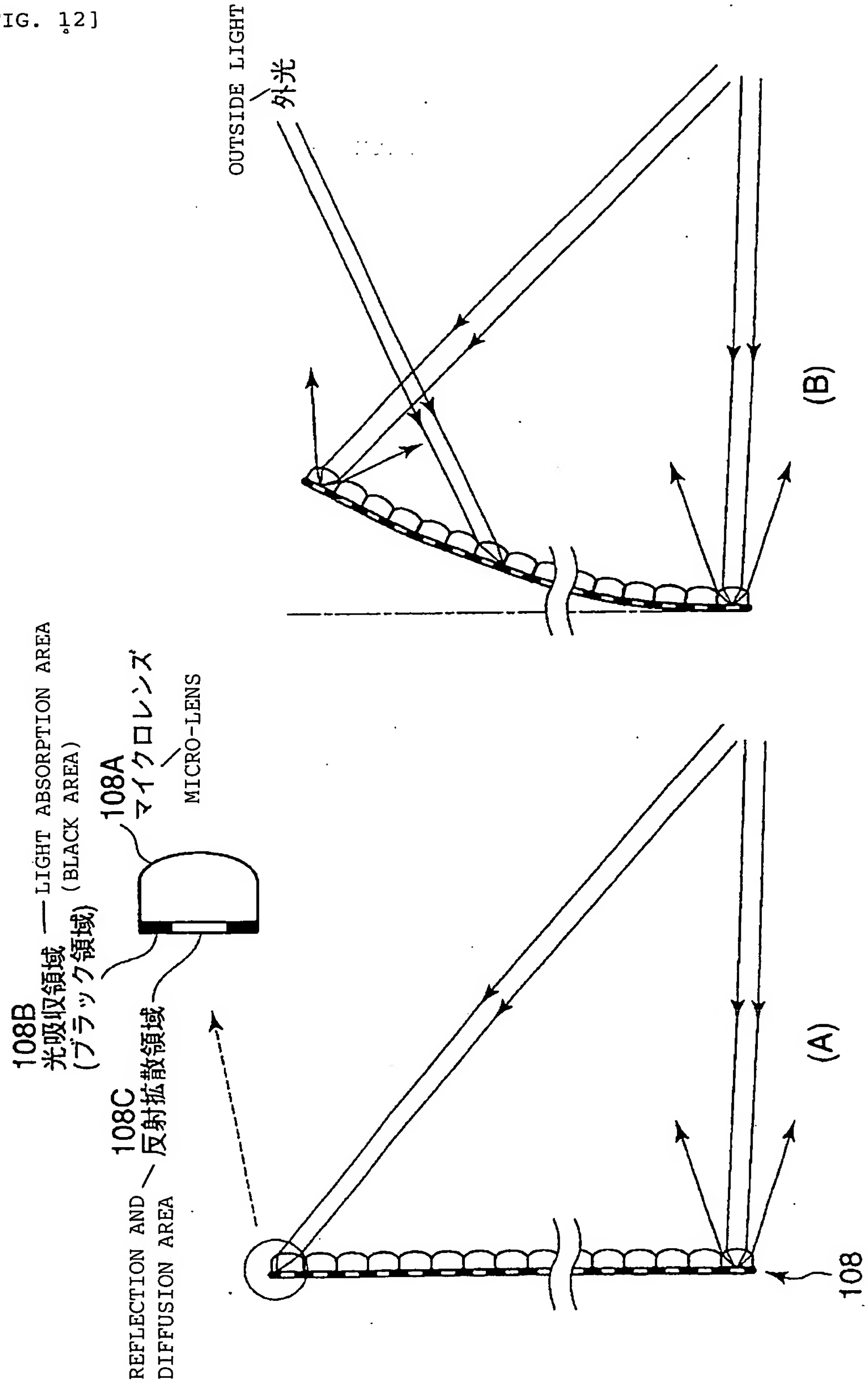


STATE AFTER DEFORMATION 変形後の状態

(B)

【図１２】

[FIG. 12]

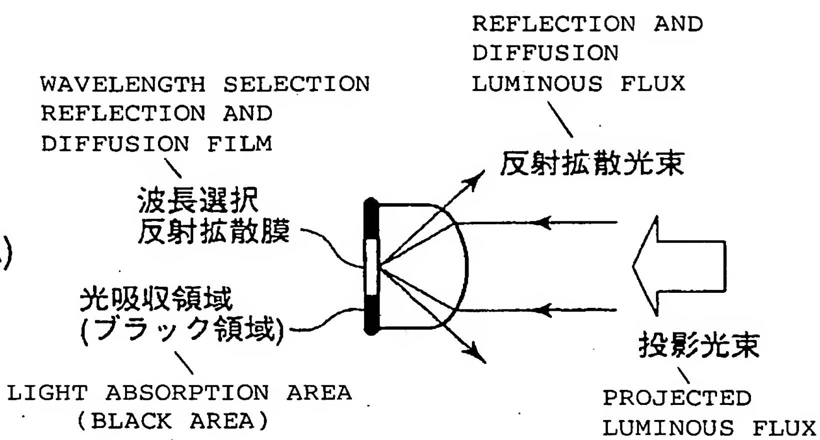


OUTSIDE LIGHT
外光
108B
光吸収領域
(ブラック領域)
LIGHT ABSORPTION AREA
(BLACK AREA)
108A
マイクロレンズ
MICRO-LENS
108C
反射拡散領域
REFLECTION AND
DIFFUSION AREA
108
(A)
(B)

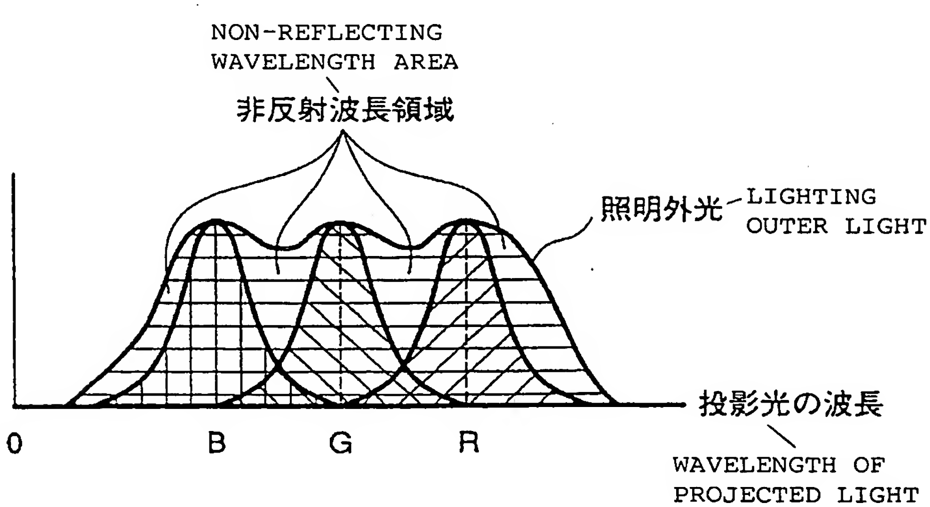
【図１３】

[FIG. 13]

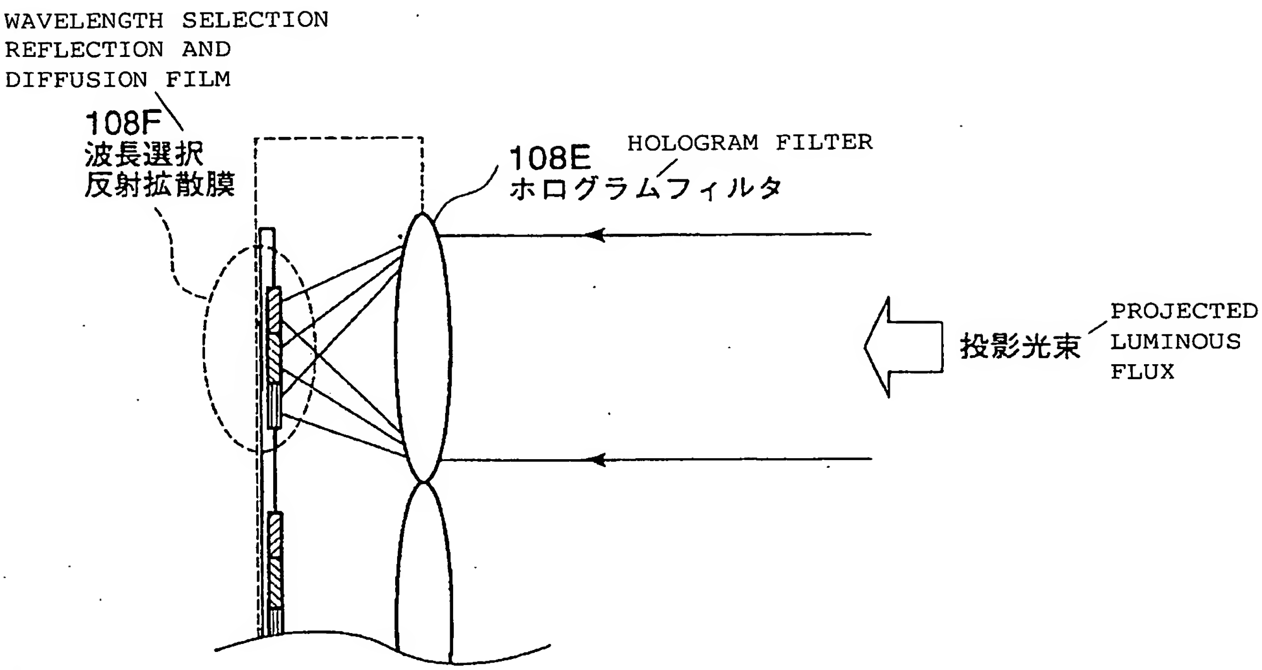
(A)


REFLECTION AND
DIFFUSION
LUMINOUS FLUX
反射拡散光束
WAVELENGTH SELECTION
REFLECTION AND
DIFFUSION FILM
波長選択
反射拡散膜
光吸収領域
(ブラック領域)
LIGHT ABSORPTION AREA
(BLACK AREA)
投影光束
PROJECTED
LUMINOUS FLUX

(B)

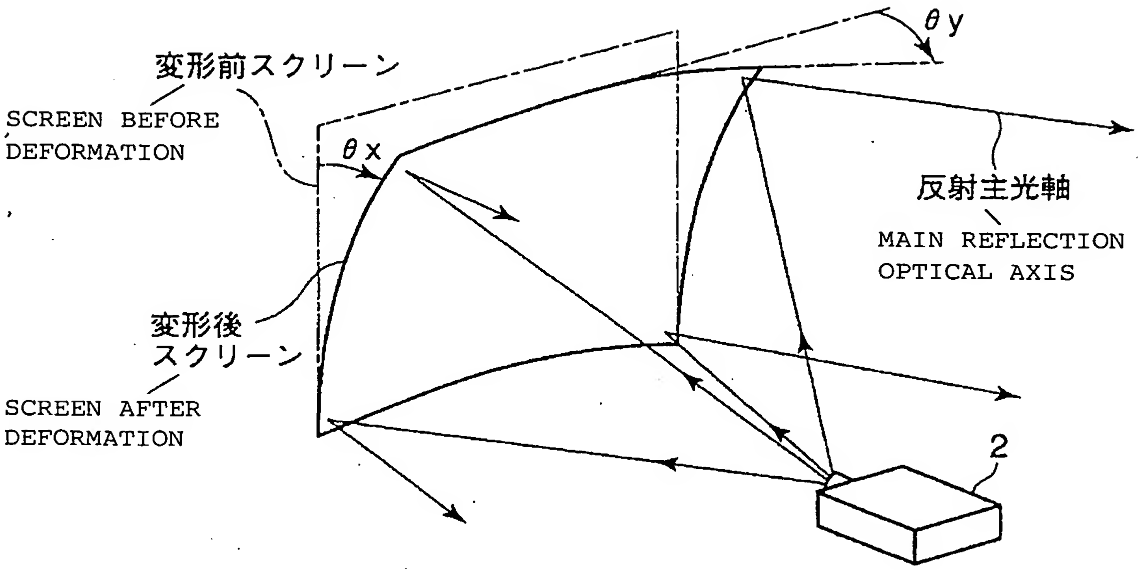

NON-REFLECTING
WAVELENGTH AREA
非反射波長領域
照明外光
LIGHTING
OUTER LIGHT
投影光の波長
0
B
G
R
WAVELENGTH OF
PROJECTED LIGHT

【図１４】
[FIG. 14]


WAVELENGTH SELECTION REFLECTION AND DIFFUSION FILM
108F
波長選択
反射拡散膜
108E
HOLOGRAM FILTER
ホログラムフィルタ
投影光束
PROJECTED LUMINOUS FLUX

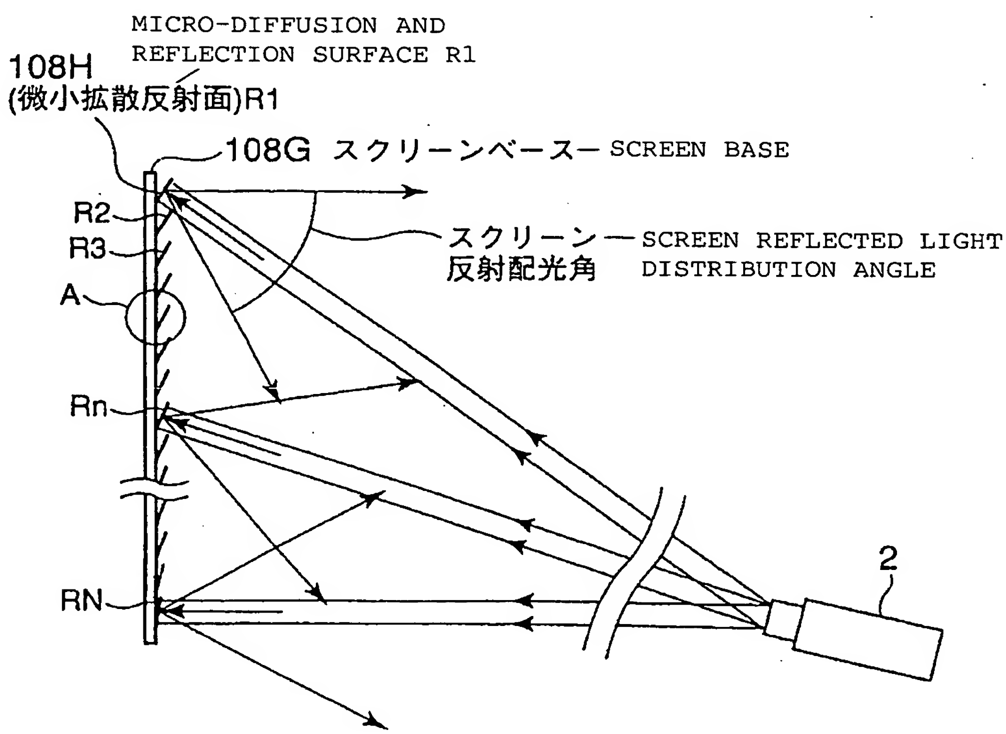
【図１５】

[FIG. 15]



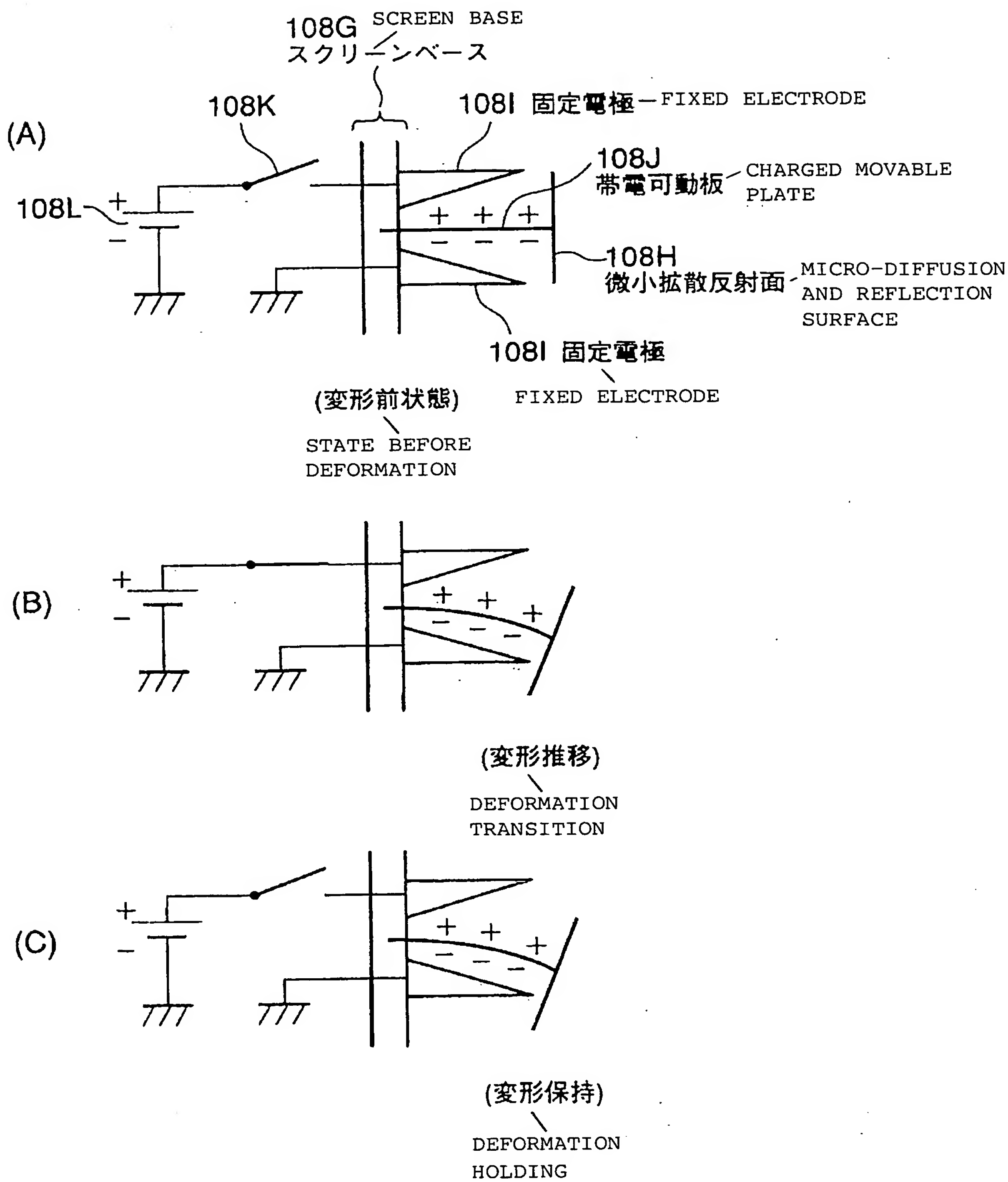
【図１６】

[FIG. 16]



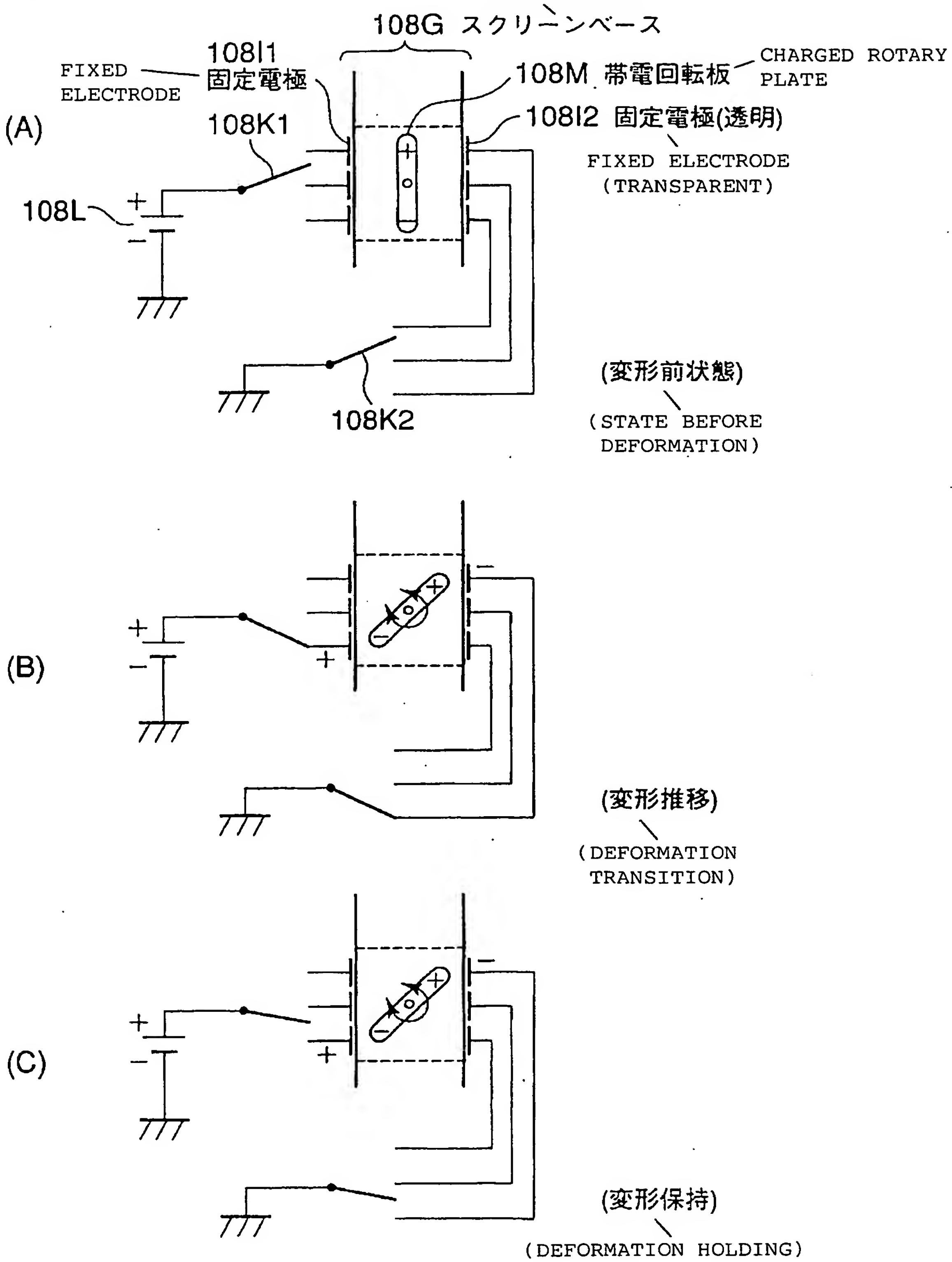
【図１７】

[FIG. 17]

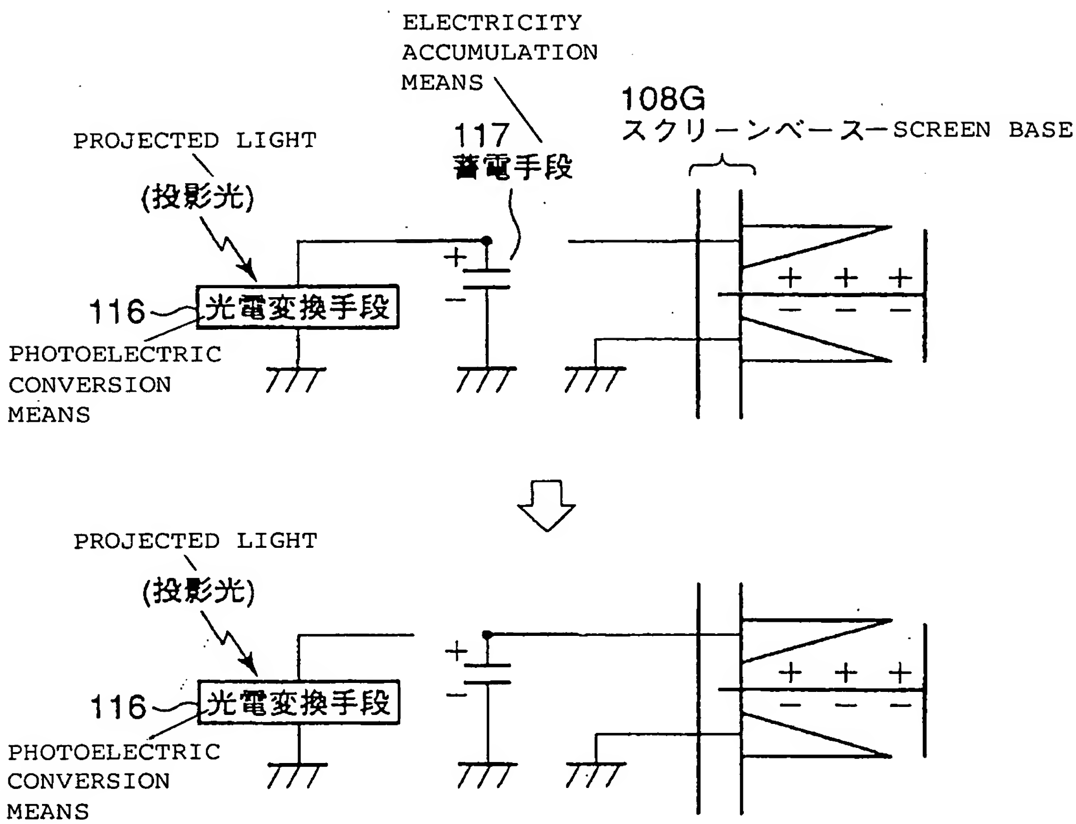

108G
SCREEN BASE
スクリーンベース
108K
108I 固定電極
FIXED ELECTRODE
(A)
108J
帯電可動板
CHARGED MOVABLE PLATE
108L
108H
微小拡散反射面
MICRO-DIFFUSION AND REFLECTION SURFACE
108I 固定電極
FIXED ELECTRODE
(変形前状態)
STATE BEFORE DEFORMATION
(B)
(変形推移)
DEFORMATION TRANSITION
(C)
(変形保持)
DEFORMATION HOLDING

【図１８】

[FIG. 18]

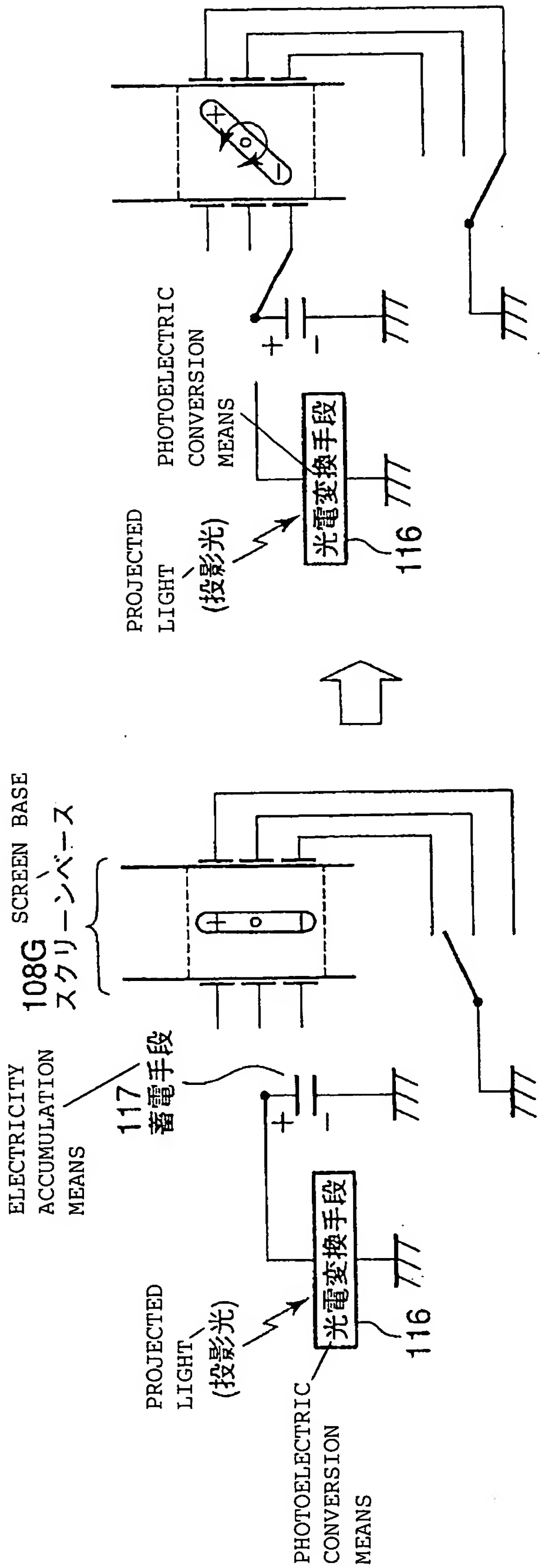

SCREEN BASE
108G スクリーンベース
108I1
固定電極
FIXED ELECTRODE
108M 帯電回転板
CHARGED ROTARY PLATE
108I2 固定電極(透明)
FIXED ELECTRODE (TRANSPARENT)
(A)
108K1
108L
108K2
(変形前状態)
(STATE BEFORE DEFORMATION)
(B)
(変形推移)
(DEFORMATION TRANSITION)
(C)
(変形保持)
(DEFORMATION HOLDING)

【図１９】
[FIG. 19]


ELECTRICITY ACCUMULATION MEANS
117
蓄電手段
108G
スクリーンベース—SCREEN BASE
PROJECTED LIGHT
(投影光)
116
光電変換手段
PHOTOELECTRIC CONVERSION MEANS
PROJECTED LIGHT
(投影光)
116
光電変換手段
PHOTOELECTRIC CONVERSION MEANS

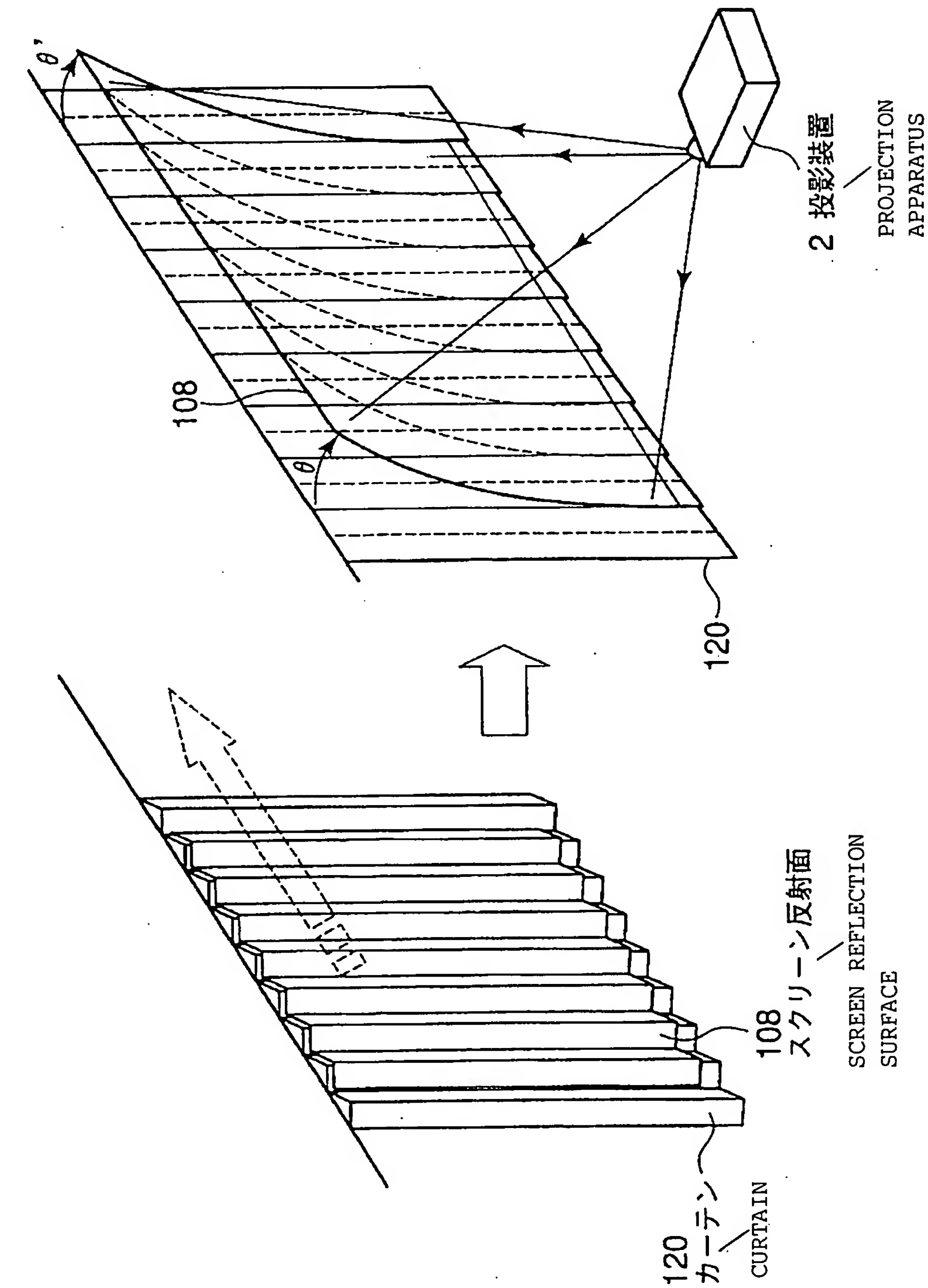
【図２０】

[FIG. 20]


PROJECTED LIGHT
(投影光)
光電変換手段
116
PHOTOELECTRIC CONVERSION MEANS
PROJECTED LIGHT
(投影光)
光電変換手段
116
PHOTOELECTRIC CONVERSION MEANS
ELECTRICITY ACCUMULATION MEANS
117
蓄電手段
108G
SCREEN BASE
スクリーンベース

【図２１】

[FIG. 21]



θ'
θ
108
120
2 投影装置
PROJECTION APPARATUS
120 カーテン
CURTAIN
108 スクリーン反射面
SCREEN REFLECTION SURFACE

[Document] ABSTRACT

[Abstract]

[Object] To effectively condense the reflected luminous flux of the screen reflection surface for the observer.

[Means for Achieving the Object] The screen reflection surface deformation control section 106 calculates the amount of deformation to provide an optimal light distribution to the observer covering area based on at least one of the incident angle of the luminous flux on the screen reflection surface 108 which has been detected by the projected luminous flux incident angle detection section 103, the data of the light distribution angle which the screen reflection surface 108 has as the reflection characteristic and which has been stored by the screen light distribution angle storage section 105, and the setting of the observer covering area by the observer covering area setting section 104, providing the control amount to the screen reflection surface deforming driving section 107. As the screen reflection surface deformation driving section 107 deforms the screen reflection surface 108 according to this control amount, reflected light are provided to the observer 3 from the screen reflection surface 108 in an effective way.

[Elected Figure] FIG. 1